TNO-rapport
FEL-96-A273

DIS, DIS++ en de High Level Architecture

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Datum
december 1996

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Rubricering

Vastgesteld door	:	Ing. F.P. Remmerswaal
Vastgesteld d.d.	:	19 december 1996

Titel	:	Ongerubriceerd
Managementuittreksel	:	Ongerubriceerd
Samenvatting	:	Ongerubriceerd
Rapporttekst	:	Ongerubriceerd
Bijlagen A - D	:	Ongerubriceerd

19970130 032

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Exemplaarnr.	:	8	
Oplage	:	32	
Aantal pagina's	:	54	(incl. bijlagen, excl. RDP & distributielijst)
Aantal bijlagen	:	4	

DTIC QUALITY INSPECTED 3

TNO Fysisch en Elektronisch Laboratorium is onderdeel van de hoofdgroep TNO Defensieonderzoek waartoe verder behoren:

TNO Prins Maurits Laboratorium
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Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO

Managementuittreksel

Titel	:	DIS, DIS++ en de High Level Architecture
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Datum	:	december 1996
Opdrachtnr.	:	A95KL841
IWP-nr.	:	758
Rapportnr.	:	FEL-96-A273

Na het pionier-project SIMNET van DARPA (*Defense Advanced Research Project Agency)* is omstreeks 1990 in de Verenigde Staten een proces in gang gezet om het concept van het koppelen van interactieve simulatoren technisch verder te onderzoeken en exploreren, èn - om interoperabiliteit tussen de heterogene simulatoren te realiseren -, standaarden te ontwikkelen om een gemeenschappelijke 'taal' voor de communicatie tussen de simulaties te definiëren. De drijvende kracht achter het concept 'DIS' (*Distributed Interactive Simulation*) en het proces 'DIS-Workshops' was in eerste instantie de USArmy en DARPA; sinds haar oprichting in 1992 daarnaast ook het DMSO (*Defense Modeling and Simulation Office).*

Aan het DIS-concept liggen twee principes ten grondslag:
1. de interacties tussen de simulatoren worden gerealiseerd door het zenden van vast gedefiniëerde boodschappen (Protocol Data Units: PDU's);
2. de simulatoren werken in real-time, gesynchroniseerd met de muurklok. De PDU's worden naar alle andere simulatoren gestuurd, waar ze met minimale vertraging ontvangen en verwerkt moeten worden.

In september 1996 werd de 15e en laatste DIS Workshop gehouden. Niet de laatste omdat het werk af is, maar omdat DMSO op een andere leest wil doorgaan (technisch en organisatorisch). Weliswaar zijn thans met de serie IEEE 1278 standaarden belangrijke mijlpalen bereikt, maar de laatste tijd werden de geluiden die de beperkingen van DIS uitten steeds luider.
De beperkingen van de DIS-protocollen zijn:
- schaalbaarheid: voor oefeningen met grotere aantallen entiteiten (bijv. boven bataljonsniveau) zijn er technische limitaties m.b.t. de verwerkingscapaciteit van simulatoren voor de PDU's en de communicatie-bandbreedte;
- betrouwbaarheid: in verband met de vereiste minimale vertraging tussen verzend- en ontvangst-tijdstip van de data worden niet-volledig betrouwbare communicatie-protocollen gebruikt. Voor sommige berichten of berichtenstromen is dat minder acceptabel;
- flexibiliteit: de rigide, vast gedefinieerde data-formaten van de PDU's bieden weinig flexibiliteit;

- tijdmanagement: voor vele andere vormen van koppeling tussen gedistribueerde simulaties zijn andere vormen van tijd-management en -synchronisatie noodzakelijk (bijv. bij *event-driven* wargames en bij simulaties voor analyse).

Om hierin tegemoet te komen (en interoperabiliteit tussen simulaties en hergebruik van simulaties te bevorderen), heeft DMSO het *High Level Architecture* (HLA) initiatief gestart. Prototype-ontwikkelingen werden ca. 18 maanden geleden door DMSO gestart. In september j.l. werd over de resultaten van de *proto-federations* gerapporteerd. Hart van de HLA is de *Run Time Infrastructure* (RTI, een zogenaamde *Application Programmer's Interface*), via welke de simulatoren/simulaties communiceren en waarvoor een formele Interface Specification geldt. Uit deze rapportages springt naar voren dat de functionaliteit van de RTI Interface Specification voor de verschillende simulatie-domeinen voldoet, maar dat de vertragingen voor real-time, man-in-the-loop platform simulatoren (nog) te groot zijn. Optimalisatie in dat opzicht is noodzakelijk.

In dat verband zijn ook de ontwikkelingen van belang in het DARPA/USACOM-project: *Synthetic Theatre of War '97*, waarin een Joint Task Force oefening gespeeld gaat worden met 10.000 - 100.000 objecten. In STOW worden zeer veel 'HLA/RTI'-technieken toegepast, respectievelijk ontwikkeld.

Het HLA-initiatief (als uitvloeisel van DoD's Modeling and Simulation Masterplan) resulteerde voorts in een Memorandum van de Under Secretary of Defense for Acquisition and Technology, gedateerd 10 september 1996, waarin HLA als de architectuur wordt aangewezen voor alle simulaties in de DoD (zie Bijlage A). Los van de technische pro's en contra's van HLA versus DIS zal een van de repercussies van dit mandaat zijn, dat op termijn ook de industriële ondersteuning van de DIS IEEE 1278 standaarden zal gaan wegebben door het wegvallen van een belangrijke markt in de toepassing ervan. Voor toekomstige (simulatie)systemen - en zeker die met een groeipotentieel - is het zaak om de blik naar HLA te richten.

Het rapport geeft een overzicht van de DIS protocollen en de standaardisatie ervan en gaat in detail in op de High Level Architecture.

Inhoud

1. Introductie

1.1 Inleiding

Dit rapport is een (tussen)rapportage van het project 'Kennisonderhoud DIS/HLA' (A95KL841) en een vervolg op eerdere rapportages, presentaties en demonstraties over het onderwerp *Advanced Distributed Simulation Technology*.

In het afgelopen jaar hebben zich in het onderwerp *Distributed Interactive Simulation* ontwikkelingen voltrokken die, althans in de 'DIS community', nogal wat stof hebben opgetrokken. De belangrijkste ontwikkeling is wel het *High Level Architecture* (HLA) initiatief van het US DoD Defense Modeling and Simulation Office (DMSO). Dit initiatief, medio 1995 gestart, resulteerde o.a. in een Memorandum van de Under Secretary of Defense for Acquisition and Technology, gedateerd 10 september 1996, waarin HLA als de architectuur wordt aangewezen voor alle simulaties in de DoD (zie Bijlage A).
In hoofdstuk 3 wordt in technische zin nader op de HLA ingegaan en op de redenen ervoor.

1.2 DIS Workshop evolutie

De standaardisatie van Distributed Interactive Simulation vindt zijn bron in de *Workshops for Standards for the Interoperability of Distributed Simulations*, welke twee keer per jaar in Orlando, FL worden gehouden. In september 1996 werd de 15e Workshop gehouden, welke de laatste was conform de opzet zoals die in het verleden is gegroeid.
In februari '96 vormde de *DIS Steering Committee* de *Special Task Group: Vision Implementation Plan (STGVIP)*, om een plan te schetsen voor de implementatie van de *'DIS Vision'* in het licht van de ontwikkeling van de HLA en de *'interoperability lessons learned of the DIS community'*[1].
De structuur en werkwijze tot nu toe was dat, op aansturing door een *Steering Committee* (bestaande uit een *Coordinating Committee, Technical Committee* en *User Sponsor Committee*), een groot aantal werkgroepen (WGs), subwerkgroepen (SWGs), special interest groups (SIGs) en focus groups (FGs) voornamelijk tijdens de workshops actief was. Op basis van ingediende en gepresenteerde *Position Papers* werden werden zaken besproken, consensus bereikt, ontwerp standaarden voorbereid en voor standaardisatie (ballot en approval) aan IEEE voorgelegd.

Thans is, naar aanleiding van de omarming van HLA, een *DIS Transition* gaande naar een andere structuur en werkwijze. Een en ander is nog niet uitgekristalliseerd maar de belangrijkste verschillen zijn dat er een wat grotere scheiding komt tussen

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1 Zie ook Bijlage D: "*The Way Ahead...DIS++*" (maart 1996)

een periodieke *Conference* en de *Standards Activity.* Vanuit de Conference zullen behoeften geuit kunnen worden naar de standaardisatie activiteit. Duidelijk is wel dat de DoD naar een meer efficiënt standaardisatie-proces wil (met gecontracteerde werkzaamheden). De Conference zou op termijn financiëel self-supporting moeten worden.

De *Standards Development Groups* die momenteel voorzien worden, zijn:
- **Architecture** SDG
- **Interface** SDG
- **Object Model Template** SDG
- **Federation Execution Development Process** SDG, en
- **Protocol Catalog** SDG

De SDG's dienen de volgende initiële DIS++ IEEE producten op te leveren:
- een overkoepelende **DIS++ Architecture** (IEEE xxxx Standard)
- **Interface Specification** (xxxx.1 Standard)
- **Object Model Template** (xxxx.2 Standard)
- **Federation Execution Development Process** (xxxx.3 Recommended Practice).

Daarnaast wordt er over gesproken om **SEDRIS** (*Synthetic Environment Data Representation Interchange Specification)* als een IEEE-standaard te ontwikkelen.

Voor de Conferences[2] wordt gedacht aan de volgende forums en aandachtsgebieden:

- **User Community Forums**
  - Analysis Forum
  - Research, Development and Engineering Forum
  - Test and Evaluation Forum
  - Small Team Training Forum
  - Staff-Level Training Forum

- **Speciality Area Forums**
  - *Infrastructure track*
    - Run-Time Infrastructure Forum
    - Communication Architecture Forum
    - Live Interaction Forum
  - *Environment track*
    - Simulated Environment Forum
    - Sensor Modeling Forum
  - *Command, Control and Communications track*
    - C4ISR Forum

2 De conferences gaan heten: *199x Spring/Fall Simulation Interoperability Workshop*; evenzo de SDGs: *Simulation Interoperability Standards Organization.*

- *Federation Development track*
  - Federation Development Process Forum
  - Exercise Management Forum
  - VV&A Forum
  - Testing Forum
- *Applications track*
  - Federation Implementers' Workshop
  - Vehicle/Weapon System Modeling Forum
  - Human Decision-making and Behavior Representation Forum
  - Logistics Forum

In Bijlage C "DIS++ Transition Frequently Asked Questions" (nov. '96) wordt meer informatie gegeven.

2. DIS standaardisatie en protocollen

2.1 IEEE-1278 standaarden

De primaire doelstelling van de DIS Workshops is de ontwikkeling van (civiele) standaarden voor interacties tussen gedistribueerde interactieve (real-time) simulaties. De volgende IEEE-documenten zijn, dan wel worden ontwikkeld:

- IEEE 1278.1-1995: Standard for Distributed Interactive Simulation - Application Protocols;
- IEEE 1278.2: Standard for Distributed Interactive Simulation - Communication Services & Profiles Requirements;
- IEEE 1278.3: Standard for Distributed Interactive Simulation - Exercise Management and Feedback Recommended Practices;
- IEEE 1278.4: Recommended Practice for Distributed Interactive Simulation (DIS) - Verification, Validation & Accreditation;
- IEEE 1278.5: Standard for Distributed Interactive Simulation - Fidelity Description Requirements.

De laatste twee in bovenstaande lijst zijn nog geen IEEE-standaard, maar zouden dat in '97 moeten worden. Naast de IEEE-documenten zijn er ook *Rationales,* welke achtergrondsinformatie geven.

De belangrijkste van genoemde documenten is wel de Application Protocols (IEEE 1278.1). Hierin worden twee conceptuele interactie-niveaus tussen entiteiten / objecten gedefiniëerd:

- welke informatie tussen de simulaties uitgewisseld moet worden en onder welke omstandigheden (Protocol Data Units)
- data representatie formaten: hoe de status variabelen en andere attributen van elke entiteit gerepresenteerd worden in deze interacties.

De feitelijke communicatieprotocollen (d.i.: **hoe** de vereiste informatie verzonden wordt tussen de simulaties) wordt in IEEE 1278.2 gespecificeerd.

De 1278.1-standaard heeft de volgende ontwikkelingsgang:

- DIS versie 1.0 van mei 1992;
- IEEE 1278 (maart 1993);
- DIS versie 2.0.3 (september 1993);
- IEEE 1278.1-1995 / "DIS versie 2.0.4" (september 1995);
- DIS versie 2.1.1 working draft (maart 1995);
- DIS versie 2.1.4 working draft (september 1996);
- IEEE 1278.1-1997 Annex (september 1997).[3]

In relatie met de Application Protocols is ook van belang het document *Enumeration and Bit-encoded Values for use with I.E.E.E. 1278.1*. Vanwege het dynamische karakter van dit document wordt hier geen IEEE-standaard van gemaakt. Versiebeheer en Change requests worden onder verantwoordelijkheid van de voorzitter van de Protocol Working Group door het Institute for Simulation and Training uitgevoerd. Recentelijk zijn, als onderdeel van het creëren van een *Data Dictionary and Protocol Catalog,* de enumeraties ook in een MS Access database beschikbaar. Onderhoud hiervan is nog onduidelijk.
Als onderdeel van de (HLA) Protocol Catalog (zie paragraaf 1.2), waarvoor DMSO verantwoordelijkheid neemt, is wel een activiteit gestart om de DIS PDU's en enumeraties om te zetten in een zgn. PnP-FOM (*Plug-and-Play Federation Object Model* zie ook paragraaf 3.2), om de geïnvesteerde kennis in DIS te beschermen en de redesign van simulatoren naar HLA-compliancy te vergemakkelen.

2.2 De Protocol Data Units (PDUs)

De IEEE 1278 (DIS versie 1) omvatte de volgende PDU's:
- Entity State
- Fire
- Detonation
- Collision, en
- een zestal PDU's voor logistieke functies (Service Request, Resupply Offer, Resupply Received, Resupply Cancel, Repair Complete, Repair Response).

De 1278.1-1995 (DIS versie 2.0) voegde daaraan toe:
- Simulation Management PDU's (12 PDU's: Create Entity, Remove Entity, Start/Resume, Stop/Freeze, Set Data, Data, Data Query, Acknowledge, Action Request, Action Response, Event Report, Message)
- Radio (Transmitter, Signal, Receiver)
- Emissions (Electronic Emission, Designator)

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3 Vanaf september '96 geeft DMSO geen funding meer voor "IEEE 1278" gerelateerde activiteiten, maar het DIS++ Transition Committee heeft uitgesproken dat deze vervolgd en per september '97 afgerond zullen zijn: "Ending the Job".

Al geruime tijd is gestudeerd op verdere functionele uitbreiding van interacties. Deze PDU's zou de DIS 2.1-serie genoemd kunnen worden. Thans ligt in vrijwel gerede versie DIS 2.1.4 voor. Deze worden een Annex aan de IEEE 1278.1-1995 standaard. Het betreft de volgende protocollen:

- **Collision-elastic**; een protocol voor botsingen, trekken, slepen, waarin (met gebruikmaking van de wetten van Newton) *high fidelity* interacties tussen twee gesimuleerde entiteiten mogelijk zijn (overdracht van lineair- en rotatie-moment, variabele elasticiteit, overdracht van moment als functie van oppervlakte-standhoeken).

- **Minefield** protocollen (Minefield PDU, Mines PDU, Minefield State PDU, Minefield Query PDU, Minefield Data PDU), waarmee met verschillende mate van detail, informatie over mijnvelden en mijnen gecommuniceerd wordt.

- **Entity State Update**: een protocol, waarmee slechts de niet-statische informatie van een entiteit wordt gecommuniceerd, waardoor een reductie van benodigde communicatie-bandbreedte te bereiken is.

- **Simulation Management w/Reliability**: de PDU's worden in principe, conform IEEE 1278.2 met het 'best effort' UDP/IP protocol verstuurd (d.w.z. zonder garantie voor correcte ontvangst). Voor het merendeel van de te verzenden data is dat acceptabel, maar voor een aantal Simulation Management PDUs (Start, Stop, Set Data, etc.) kan een hoge betrouwbaarheid noodzakelijk zijn.

- **IFF/ATC/NAVAIDS**: om informatie te communiceren m.b.t. functies zoals coöperatieve IFF-systemen, Air Traffic Control Beacons en Transponders en andere navigatiesystemen.

- **Underwater Acoustic**: t.b.v. de informatie overdracht omtrent passieve en actieve akoustische emissies.

- **Intercom** (Intercom Control en Intercom Signal): t.b.v. intercom communicatie in DIS oefeningen. Dit protocol ondersteunt (met overdracht van digitale data) de conversatie tussen twee partijen en tussen meerdere partijen gelijktijdig. De Intercom Signal PDU is in feite exact gelijk aan de Signal PDU van het Radio protocol.

- **Entity Management** (Aggregate (Aggregate State, Action Request, Action Response, Event Report), Entity Handover, IsPartOf, IsGroupOf): voor het besturen van entity aggregatie activiteiten, de overdracht van de *ownership* van een entiteit tussen verschillende simulaties en om een hiërarchisch verband aan te geven tussen separaat gesimuleerde entiteiten (zoals bijv. een missile dat aan de vleugel van een een vliegtuig hangt, maar na lancering een 'eigen leven'

leidt).

- **Environment** (Environmental Process, Gridded Data, Point Object State, Linear Object State, Areal Object State): protocollen om veranderingen in de gesimuleerde omgeving tijdens de oefening te communiceren. De eerste twee (met minder, respectievelijk meer resolutie) t.b.v. meteorologische veranderingen (wind, rook, heïigheid, zonnestand, etc.), de Object State PDUs t.b.v. veranderingen aan (vaste) objecten in de synthetische omgeving/terrein. Het gebruik van deze protocollen vergt overigens ook een *Environment Server* om de wijzigingen bij te houden / te beheren.

- **Non-Real Time Protocol**: een protocol om in de simulaties de tijd sneller of langzamer dan de muurklok te laten lopen.

- **Field Instrumentation**: ten behoeve van geïnstrumenteerde *life* systemen. Bij dergelijke systemen is o.a. de communicatie-bandbreedte (via radiokanalen) een bottleneck. De *Field Instrumentation* PDU's is een set van protocollen (met ingeperkte functionaliteit), die in de plaats treedt van alle hiervoor genoemde protocollen. Karakteristiek is bijvoorbeeld de TSPI-PDU, waarin *Time, Space* en *Position* informatie van een entiteit gecommuniceerd wordt. Hierbij kan de PDU van variabele lengte zijn, omdat niet alle informatie in elke *broadcast* aanwezig behoeft te zijn.

2.3 Ending the job

De hiervoor vermelde PDU's vormen een tamelijk complete set van protocollen om (real-time voor menselijke perceptie) de gebeurtenissen in een synthetisch/virtueel gevechtsveld te beschrijven en de interacties tussen gesimuleerde wapenplatformen te specificeren. Vele van deze PDU's zijn ontstaan uit de functionele behoefte in het project *Close Combat Tactical Trainer* (CCTT) van de USArmy. Op een aantal van deze protocollen dient ook bij TNO-FEL de kennis en ervaring verdiept te worden. Met name geldt dit voor Radio, Intercom, Environment (dynamische veranderingen in het synthetische terrein).

In het licht van de onder 1.2 vermelde omarming van HLA zal een verdere optimalisatie van de DIS-standaarden waarschijnlijk niet plaatsvinden. Wel wordt de in de DIS-community opgebouwde kennis meegenomen in het HLA-vervolg traject. Het noodzakelijke beheer van de bij de PDU's behorende *Enumerations and Bit-Encoded Values* is een probleem, omdat dit niet bij IEEE is/wordt ingebracht en DoD geen financiering meer geeft voor DIS-georiënteerde zaken.

3. High Level Architecture

3.1 Inleiding

Het US Defense Modeling and Simulation Office (DMSO) heeft de opdracht gegeven tot de ontwikkeling van standaarden ter ondersteuning van alle *Modeling* en *Simulation* activiteiten binnen het US *DoD* (Department of Defense). Dit heeft geleid tot de ontwikkeling van de *High Level Architecture*, een architectuur die als basis zal dienen voor alle toekomstige gedistribueerde simulatie applicaties. Het doel van de HLA is tweeledig:

1. Interoperabiliteit tussen simulatiemodellen:
   Het is zeer wenselijk simulatiemodellen uit verschillende gebruikersdomeinen te integreren in een gezamenlijk scenario. B.v. de integratie van real-time, man-in-the-loop platform simulatie met wargame-achtige, event-driven simulatie. De situatie op dit moment is dat deze simulaties niet op elkaar aan te sluiten zijn, aangezien de eerst genoemde groep simulaties gebruik maakt van het *DIS*-protocol (Distributed Interactive Simulation) en de tweede groep van het *ALSP*-protocol (Aggregated Level Simulation Protocol). HLA combineert de voordelen van beide standaarden.

2. Hergebruik van simulatie modellen:
   Door standaarden te definiëren die verder gaan dan het vastleggen van een netwerk protocol en die als het ware de architectuur van alle simulatie modellen vastleggen, wordt hergebruik van bestaande modellen eenvoudiger, met name door de object-georiënteerde opzet van het HLA.

In augustus '96 is een HLA *baseline* opgeleverd. Deze eerste versie is vrij verkrijgbaar binnen de US, maar nog niet voor buitenlanders. Deze baseline bevat de volgende componenten:

1. RTI prototype:
   De *Run-Time Infrastructure* (RTI) is een implementatie van een gedistribueerde systeem- en interconnectielaag, die als basislaag dient voor alle HLA applicaties. Deze laag verzorgt de communicatie tussen alle simulatiemodellen.

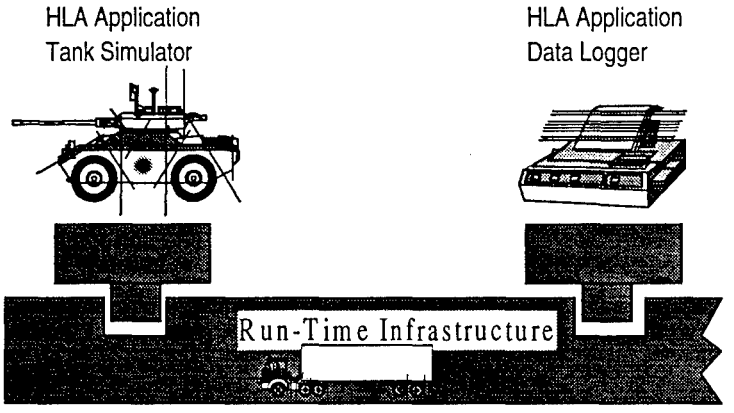
2. Interface Specification:
   De *Interface Specification* is een formele, functionele beschrijving van het interface tussen enerzijds de HLA applicatie (b.v. een tanksimulator) en anderzijds de RTI.

3. Rules:
   Een verzameling van technische principes en afspraken waaraan HLA deelne-

mers zich moeten houden om HLA-compatible te zijn.

4. Object Model Templates (OMT):
   De *Object Model Templates* zijn gestandaardiseerde formaten die gebruikt worden om de functionaliteit van simulatiemodellen vast te leggen alsmede de interactie tussen deze modellen. Op deze manier wordt vòòr de oefening vastgelegd wat de '*capabilities*' van alle deelnemende simulatiemodellen zijn en welke interactie/interpretatie van de gegevens kan plaatsvinden (b.v. resolutie, wel/geen voice). Tijdens de oefening mag niet worden afgeweken van deze specificaties omdat andere deelnemende simulaties anders de ontvangen informatie niet kunnen verwerken.

Deze componenten worden in de paragraaf *Status* verder beschreven.



Figuur 1: RTI gedistribueerde communicatielaag.

3.2 Architectuur

Alvorens de architectuur van HLA nader toe te lichten, omschrijven we eerst een aantal termen:

Federate
HLA-compatible applicatie zoals simulatoren, data collectors, semi-automatic forces, simulation management tools en presentatiegereedschappen zoals 3D-Stealth en Audio servers.

Federation
Verzameling van participerende federates. Deze federates moeten zich houden aan de Federation Object Model die voor deze federation is opgesteld.

Federation Object Model (FOM)
Contract tussen federates die alle toegestane interacties tussen de federates vastlegt. Het beschrijft dus op hoog niveau de interface tussen alle applicaties.

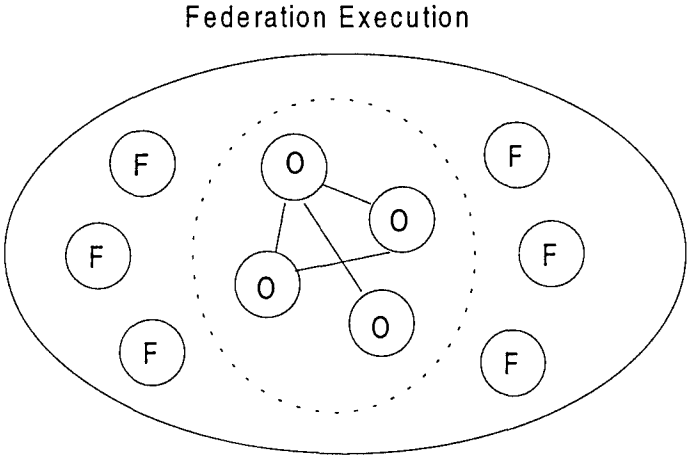
Simulation Object Model (SOM)
De SOM specificeert de 'capabilities' van een federate. Met andere woorden: wat is de functionaliteit van de applicatie. Deze opzet bevordert hergebruik van reeds bestaande simulatiemodellen.

Object
Entiteit met unieke identificatie binnen de federation. Denk b.v. aan simulatiemodellen van tanks en vliegtuigen. Objecten hebben een status die bepaald wordt door de huidige waarden van hun attributen. Objecten interacteren met ander objecten zoals formeel vastgelegd is in de FOM. Dit kan door middel van interactions (berichten die van object naar object worden gestuurd) of door het distribueren van object attributen.

Attribute
Element van een object. B.v. voor een tankobject zijn positie, snelheid en oriëntatie attributen. De attributen vormen samen de status van het object. Andere objecten kunnen attribuutwaarden van een object opvragen.

Interaction
Objecten kunnen elkaar berichten toesturen via interactions. Als een tanksimulator bijvoorbeeld vuurt, zal hij dit door middel van een interaction aan de buitenwereld bekend maken.

Federation execution
Het verloop van de federation oefening (session). Schematisch ziet het er als volgt uit:



Figuur 2: Federation Execution.

De federation bestaat uit een aantal federates (F) die een aantal objecten (O) geïnstantieerd hebben, zoals in de FOM en SOMs is vastgelegd. Deze objecten communiceren via interactions en kunnen ook elkaars attributen benaderen. Elk object attribute wordt door één federate beheert, m.a.w. deze federate is de eigenaar. Alleen de eigenaar kan de attribute waarde veranderen, anderen kunnen de waarde alleen lezen. Zo kan het zijn dat attribute A van object 1 van federate F is, terwijl attribute B van hetzelfde object door federate G wordt ingevuld. Het is ook mogelijk 'ownership' aan andere federates over te geven.

Het HLA biedt via de Run-Time Infrastructure (RTI) de volgende functionaliteit aan de HLA applicaties:

1. Federation Management services:
   Federates hebben de volgende middelen voor simulation management-achtige acties.
   - Create/destroy execution
     Het creëren of verwijderen van federation executions. Alleen de Federation Manager (één van de federates) kan dit doen.
   - Join/resign execution
     Het 'inloggen' en 'uitloggen' van een federate bij een federation execution. Na registratie ontvangt de federate alle informatie waarop hij "geabonneerd" is.
   - Pause/resume execution
     De Federation Manager is in staat de execution tijdelijk te onderbreken en later weer te hervatten.
   - Save/restore execution
     De Federation Manager kan de huidige status van de federation execution opslaan en later weer terugladen. Met name voor analyse en debriefing doeleinden is dit vereist.

2. Declaration Management services:
   Deze functionaliteit dient om de netwerkbelasting te reduceren en federates onnodig rekenwerk te besparen. Dit wordt gerealiseerd door alleen relevante informatie naar een federate te sturen. Het uitgangspunt is om zoveel mogelijk aan de zendende kant filtering van informatie uit te voeren.
   - Subscription
     Elke federate abonneert zich op object attributes en interactions die voor hem van belang zijn. Hij zal dan daarna alleen deze object informatie (en relevante wijzigingen daarin), ontvangen. Subscriptions mogen tijdens de execution (dynamisch) gewijzigd worden. Federates kunnen zich niet alleen abonneren op attribute-typen maar ook op attribute-waarden. Zo kan een federate zich b.v. abonneren op alle entiteiten die zich in zijn directe (sensor)omgeving bevinden op basis van de waarde van de positie-attribuut.
   - Publication
     Elke federate vertelt de federation welke informatie hij tijdens de execution

aan zal bieden. Andere federates kunnen zich daar dan op abonneren. Ook deze publications kunnen tijdens het verloop van de simulatie-sessie gewijzigd worden.

3. Object Management services:
   Communicatie tussen federates d.m.v. objecten en interactions.
   - Instantiate/delete object
     Een federate kan objecten bij de federation registeren en later weer afmelden.
   - Update/reflect object attribute
     De eigenaar van een object attribute kan de waarde veranderen. Anderen, die geabonneerd zijn op dit attribute, ontvangen deze nieuwe informatie.
   - Request/provide object attribute
     Geabonneerde federates worden van veranderde object attributes automatisch op de hoogte gesteld. Een federate kan echter ook expliciet een object attribute opvragen, waarna de waarden van de attribute naar hem verstuurd zal worden.
   - Send/receive interaction
     Objecten en federates kunnen ook via messages met elkaar communiceren.

4. Ownership Management services:
   Elk object wordt in principe beheerd door de federate die het object geïnstantieerd heeft. Het is echter mogelijk de 'ownership' van attributen over te dragen aan andere federates. Een praktisch voorbeeld hiervan is een tanksimulator die uitgerust wordt met een nieuw, geavanceerder bewegingsmodel. Dit bewegingsmodel is een federate die eigenaar wordt van de positie-attribute van de tank federate en zo de actuele positie kan specificeren.

5. Time Management services:
   Aangezien HLA een breed scala van toepassingsgebieden moet ondersteunen zijn de hieronder beschreven *message ordering* methoden gedefinieerd. Deze methoden beschrijven hoe de RTI voor de federate moet omgaan met binnenkomende informatie, er van uitgaande dat verstuurde berichten niet altijd in de juiste volgorde bij de ontvangende RTI aankomen.
   - Receive order
     Berichten worden in volgorde van binnenkomst doorgegeven aan de applicatie. Er vindt dus geen ordening plaats. Deze methode wordt voornamelijk in real-time, man-in-the-loop simulatie toegepast.
   - Priority order
     Berichten tot een bepaald tijdstip worden op timestamp (d.w.z. de tijd dat het bericht verzonden is) gesorteerd. Dit garandeert niet dat er later nog berichten binnen kunnen komen met een vroegere timestamp.
   - Causal order
     Bepaalde causale verbanden bepalen de berichten-volgorde naar de applica-

tie. Bijvoorbeeld de ontvangst van een detonation event nà de ontvangst van de bijbehorende fire event.

- Timestamp order
  Berichten worden op timestamp gesorteerd met de garantie dat er geen berichten met een vroegere timestamp meer binnenkomen (lees: worden verwerkt door de RTI). Bij deze methode is per federate een *look-ahead*-factor vereist, die aangeeft hoelang de applicatie in de toekomst geen berichten meer zal versturen. Een applicatie die een look-ahead van 10 seconden specificeert, belooft als het ware dat hij de komende 10 seconden geen berichten zal versturen. Dit geeft vaak een praktisch probleem bij man-in-the-loop simulatie omdat menselijk gedrag moeilijk voorspelbaar is en de look-ahead factor dus 0 is.

HLA onderscheidt twee orthogonale factoren binnen Time Management: 'paced' en 'agreement'. 'Paced' geeft aan of de federation time gekoppeld is aan een muurklok. 'Agreement' bepaalt of voor een tijdvoortgang toestemming van de federation moet worden gevraagd. Deze twee factoren kunnen worden gecombineerd tot vier categoriën van time management:

I paced with agreement
II paced with no agreement
III not paced with agreement
IV not paced with no agreement.

Bij categorie II kan gedacht worden aan real-time, DIS-achtige simulaties en bij categorie III aan event-driven, ALSP-achtige simulaties. Bij categorie I is te denken aan simulaties voor analyse, waarbij er een muurklok is en federates in een bepaalde volgorde moeten worden opgestart. Categorie IV representeert event-driven simulaties, waarbij elke federate zijn eigen tijdlijn volgt, zonder synchronisatie (bijv. 'run-as-fast-as-possible'.

	Synchroon met muurklok	Tijdvoortgang
DIS	ja	iedere federate onafhankelijke tijdvoortschrijding
ALSP	nee	gecoördineerd

De federate en *niet* de RTI is verantwoordelijk voor het bijhouden van object status-informatie. De RTI is slechts een mechanisme om te communiceren tussen federates en geeft de attributen door aan de federate.

3.3 Verschillen tussen DIS, ALSP en HLA

Een aantal verschillen tussen DIS, ALSP en HLA:

- DIS en ALSP zijn protocollen; HLA is een architectuur.

- DIS werkt voornamelijk met niet-gegarandeerde connectionless communicatie (UDP/IP multicast); HLA daarentegen op basis van connection oriented communicatie (TCP/IP point-to-point).
- DIS is slecht schaalbaar; HLA lijkt redelijk goed schaalbaar (door declaration en subscription management).
- DIS ondersteunt real-time, man-in-the-loop simulatie; HLA generieke simulatie.
- DIS heeft zich reeds bewezen; HLA nog niet.
- DIS standaarden en deliverables zijn commerciëel verkrijgbaar; HLA, d.w.z. RTI implementaties, (nog) niet voor buitenlanders.

3.4 HLA Status

Er is op dit moment een HLA Baseline (versie 1.0) die de volgende, in paragraaf 3.1 beschreven componenten bevat:

1. RTI prototype
2. Interface Specification
3. Rules
4. Object Model Templates

In de volgende paragrafen bespreken we de status en inhoud van deze afzonderlijke componenten.

3.4.1 RTI prototype

De *Run-Time Infrastructure* (RTI) is een implementatie van een systeem- en interconnectielaag die als basislaag zal dienen voor toekomstige HLA applicaties. Deze basislaag verzorgt de communicatie tussen alle simulatiemodellen. Het RTI prototype is in de Verenigde Staten vrij verkrijgbaar. Of de RTI voor andere landen beschikbaar komt, is nog onbekend[4].

Het huidige prototype was oorspronkelijk gebaseerd op CORBA 1.0 m.b.v. de commerciële software development tool ORBIX™. CORBA (Common Object Request Broker Architecture) is een bestaande standaard om objecten te distribueren en te laten communiceren over een netwerk. De gebruiker kan deze objecten raadplegen zonder te weten op welk computersysteem het object zich in feite bevindt. Aangezien ORBIX niet voldoet aan de stringente eisen van de HLA gemeenschap, zal ORBIX in de volgende versies vervangen worden door een eigen implementatie. Ook is er voor DMSO een prototype RTI ontwikkelt die niet op CORBA gebaseerd is, maar op C++. De RTI gebruikt CORBA's IDL (Interface Definition Language) als Application Programming Interface (API) naar de federate. De volgende RTI versie zal een C++ API bevatten.

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[4] Via bilaterale overeenkomsten (FMS, DEA, MOU) kunnen NATO-partners een RTI-versie verwerven.

Een aantal *protofederations* die elk een gebruikersgroep vertegenwoordigen hebben met de RTI geëxperimenteerd:

Warfighting (Platform) Federation:
Real-time man-in-the-loop simulatie op platform niveau voor het trainen van platform- en staf personeel. Deze protofederation vertegenwoordigt een groot deel van de DIS-gemeenschap.

Aggregate Federation:
Aggregate-level simulatie op peletonsniveau voor het trainen van stafpersoneel. Vertegenwoordigt de ALSP (Aggregate Level Simulation Protocol) gemeenschap. Denk bijvoorbeeld aan wargames en event-driven simulatie.

Analysis Federation:
Constructieve simulatie (computer generates forces zoals b.v. ModSAF) en scenario management tools voor analyse doeleinden.

Engineering Federation:
Ontwerp, test en evaluatie van vliegtuig subsystemen gerelateerd aan EOV en counter-measures. Dit gebaseerd op de HLA-omzetting van eerdere gedetailleerde, high-fidelity DIS-federates.

Joint Training Federation Prototype
Hierbij werden bestaande ALSP en DIS-federates samengevoegd tot een federation. Er werden geen problemen met de causaliteit geconstateerd. Dit vanwege de betrouwbare en gegarandeerde aflevering van informatie.

Alle protofederations zijn tot de conclusie gekomen dat de functionaliteit van de RTI voldoet aan hun specifieke eisen. Ze zijn het er ook over eens dat de performance van de RTI ver beneden peil ligt met *latencies van 1200 msec*, soms zelfs hoger. Dit wordt ten dele veroorzaakt door de wijze van connection-oriented communicatie: er moet gewacht worden op een acknowledgement van de andere federate(s) voordat de "update" gerealiseerd is. Vreemd genoeg blijkt de communicatie niet gelijkelijk over de tijd gedistribueerd te zijn, maar is er sprake van "blokvorming" in de communicatie. Gegeven de eisen van betrouwbare communicatie, treden hierdoor pieken op in de netwerkmedia bezetting en de afhandeling van pakketten.
De huidige versie van HLA/RTI werd hierom tijdens de DIS-transition workshop vergeleken met een "Formule 1 wagen op stenen wielen".
Een ander opvallend gegeven is dat het langzaamste systeem in een federation de bottleneck vormt. Dit omdat de RTI voortgang opgehouden wordt totdat dit systeem de informatieontvangst bevestigd heeft !

Vooral de Platform Federation toont zich hier bezorgd over. De RTI bouwers beweren dat er in dit prototype alleen naar functionaliteit is gekeken en nog helemaal niet naar performance. Het blijft voorlopig onzeker of de RTI-performance in de toekomst goed genoeg zal worden voor real-time applicaties die een lage latency vereisen zoals 'fast movers' en 'close combat' (met name vliegtuig en missile simulaties).

Nieuwe concepten in de RTI, als object en attribute "hand-over" blijken, soms tot verbazing van de proto-federation testers, functioneel goed te werken.

3.4.2 Interface Specification

De *Interface Specification* is een formele, functionele beschrijving van het interface tussen enerzijds de HLA-applicatie (b.v. een tank simulator) en anderzijds de RTI.

De Interface Specification biedt functies voor de reeds eerder vermelde vijf RTI Services:

1. Federation Management
2. Declaration Management
3. Object Management
4. Ownership Management
5. Time Management

De protofederations hebben gemeld tevreden te zijn met de geboden Interface Specification functionaliteit. Vandaar dat het interface in de toekomst waarschijnlijk vrij stabiel zal blijven. Het interface is van beide kanten benaderbaar. D.w.z. dat de federate services kan aanroepen die de RTI levert, maar ook dat de RTI services aanroept die de federate moet leveren! Bijvoorbeeld bij binnenkomst van een up-to-date attribute zal de RTI een federate-defined function aanroepen die de attribute afhandelt.

3.4.3 HLA Rules

Dit is een set van technische principes (de "Ten Commandments" van HLA) waaraan HLA deelnemers zich moeten houden om HLA-compatible te zijn.

Federation Rules:

1. Elke federation moet een Federation Object Model (FOM) hebben (de FOM wordt vastgelegd conform de gestandaardiseerde formaten in de Object Model Templates (OMT)).

2. Alle object informatie (status, ownership) bevindt zich in de federate, *niet* in de Run-Time Infrastructure (de federate is daarmee verantwoordelijk voor de object presentatie).

3. Informatieuitwisseling (attributes of interactions) tussen de in de FOM gespecificeerde objecten loopt uitsluitend via de Run-Time Infrastructure.

4. Federates interacteren met de Run-Time Infrastructure conform de HLA Interface Specification.

5. Slechts één federate kan op enig tijdstip eigenaar zijn van een attribute van een instantie van een object. Het 'ownership' kan wel overgedragen worden aan een andere federate.

Federate Rules:

1. Elke federate moet een Simulation Object Model (SOM) hebben conform de gestandaardiseerde formaten in de Object Model Templates (OMT).

2. Federates moeten in staat zijn attributen van objecten te publiceren of reflecteren zoals in hun SOM beschreven staat. Dit geldt ook voor interactions.

3. Federates moeten in staat zijn attributen van objecten te beheren (d.w.z. eigenaar zijn) en 'ownership' over te dragen of over te nemen.

4. Federates moeten in staat zijn drempel waarden (thresholds) te wijzigen die bepalen wanneer attributen ge-update moeten worden.

5. Federates moeten in staat zijn een lokale klok bij te houden om conform ten minste één time management service aan de federation deel te nemen.

3.4.4 Object Model Templates

De *Object Model Templates* zijn gestandaardiseerde formaten die gebruikt moeten worden om de functionaliteit van simulatie modellen vast te leggen en de interactie tussen deze modellen. Op deze manier wordt vòòr de oefening vastgelegd wat de *'capabilities'* van alle simulatie modellen is. Tijdens de oefening mag niet worden afgeweken van deze specificaties.

We onderscheiden de volgende tabellen:

- Class Structure Table:
  Specificatie van object klasse hierarchie (class-subclass relaties). B.v. Tank behoort tot de klasse LandVehicle en LandVehicle behoort tot de klasse Platform.

- Component Structure Table:
  Specificatie van object componenten hiërarchie (part-whole relaties). B.v. Tank bestaat uit de componenten WeaponSystem, Radar etc.

- Association Table:
  Specificatie van verdere relaties tussen objecten die uitwisseling van attribuut-

waarden mogelijk maken. Bijv. Radar is geïnteresseerd in positie-attribute van Tanks.

- Object Interaction Table:
  Specificatie van berichten verkeer (interactions) tussen objecten. Bijv. Tank vuurt en stuurt de corresponderende interaction naar de andere Tanks.

- Attribute Table:
  Specificatie van alle attributen en interactions wat betreft data type, units, resolutie, nauwkeurigheid etc.. Bijv. Tank heeft een gewicht-attribute van het type double, kilogram etc.

- Data Dictionary:
  Alfabetische lijst van alle classes, attributes, interactions, associations met tekstuele uitleg en structuur.

3.5 Beveiliging en HLA

Door Trusted Information Systems Inc. (TIS) wordt een security architectuur ontwikkeld voor HLA. De beveiligingsproblematiek wordt in verschillende stappen aangepakt. Op korte termijn is alleen een federation op basis van "System High" mogelijk. "System High" is een omgeving waarin alle gebruikers/ deelnemers minimaal tot het hoogste te gebruiken beveiligingsniveau (bijv. US Secret) gecleared zijn.

Op middellange termijn (ca. vijf jaar!) is scheiding tussen twee beveiligingsniveaus, bijv. Geheim en Confidentieel, mogelijk door ieder beveiligingsniveau als een aparte netwerk op te zetten, waarbij een "guard" (op federate-niveau) optreedt als veilige gateway-koppeling tussen beide netwerken. In TCSEC-termen dient de guard minimaal te voldoen aan B3-normen, hetgeen de ontwikkel- en evaluatietijd sterk nadelig beïnvloedt. Vervolgens kan accredidatie in de werkomgeving plaatsvinden.

Pas op lange termijn wordt gedacht aan een multi-level beveiligde oplossing.

Bij de middellange termijn-oplossing, de guard, is sprake van drie FOM's: twee FOM's voor de beschrijving van beide rubriceringsomgevingen en een gecombineerde FOM die de *toegestane* interactie ("sanitation rules") en uit te wisselen objecten tussen beide omgevingen vastlegt.
Voor iedere federation is sprake van één enkele beveiligings-policy, een gezamenlijk bezit en gedeelde verantwoordelijkheid voor de toegestane uit te wisselen attributen van objecten die tussen de beveiligingsniveaus ge"shared" mogen worden.

Voor de after-action reviews zal dit zeker problemen geven, omdat b.v. een vliegtuig-federate in de confidentiële omgeving b.v. een object-id 109 heeft en, indien dit object zichtbaar mag zijn in de geheime omgeving, daar een volkomen ander object-id krijgt. Dit omdat de FOM's geen inzicht hebben in de "externe" relaties achter de RTI. Loggings zijn dus niet meer samen te voegen, tenzij alle attributen in de "share FOM" worden geplaatst en de logger op "hoog beveiligingsniveau" zich daar op abonneert.

Omdat de evaluatie van een guard zeer problematisch is, probeert TIS de guard zodanig te ontwerpen en te ontwikkelen, dat deze schaalbaar en veilig configureerbaar is. Zaken die bestudeerd worden zijn: schaalbaarheid, beveiligingsimplicaties van filtering, performance, (on)gewenste signaleringskanalen, deductie van vertrouwelijke gegevens uit vrijgegeven informatie en spoofing.

Op dit gebied dienen nog vele concepten uitgediept te worden, zeker als multinationale interoperabiliteit aan de orde komt.

4. STOW

Binnen het Synthetic Theatre Of War (STOW) wordt gewerkt aan grootschalige simulaties met meer dan 10.000 entiteiten, gebaseerd op de HLA-technologie. De complexiteit van deze hoeveelheid entiteiten vergen een enorme netwerkcapaciteit indien voortgebouwd zou worden op de DIS-wijze van connecties tussen federates. Daarnaast kunnen de simulatoren de grote hoeveelheden data niet tijdig verwerken of is een (onnodig) grote verwerkingscapaciteit nodig. Als voorbeeld werd gesteld dat CPU's 100-150 microseconden nodig hebben om een informatiepakket te verwerken.

Gestudeerd wordt op technieken om de benodigde hoeveelheid data-transporten te minimaliseren. De RTI-aanpak, waarbij een federate zich "abonneert" op object attributen helpt daarbij. Met name als de object instantiaties zich niet of langzaam bewegen (b.v. uitgestegen entiteiten; logistieke acties als laden of lossen).

Gekeken wordt naar een optimale wijze van filteren van informatie in de RTI. Hierbij kan op verschillende plaatsen gefilterd worden: door de informatiezender, door het netwerk of door de ontvanger. Hierbij is het van belang de "routing spaces" te onderkennen: welke informatie is belangrijk en hoe moet deze gerepresenteerd zijn (bijv. km versus mijlen).

Bij zender gedreven filtering, meldt een federate aan een andere RTI de interesse in de gegevens binnen een bepaald gebied (region), bijvoorbeeld "alles in de zichtomgeving". De RTI werkt de object attributen bij en selecteert vervolgens de informatie die de "abonnee" nodig heeft en verstuurt die.

Ingeval van receiver based filtering, bouwt de ontvanger een boom op met meerdere "regions of interest", die steeds fijner opgedeeld zijn. Via het netwerk wordt vervolgens een optimale verbindingsboom onderhouden, waardoor de hoeveelheid gegevens via het netwerk binnen redelijke grenzen blijft.

Uitgaande van gegevens van een eerdere STOW exercitie, blijkt zender based filtering met een 2-5 km grid circa 30% reductie in netwerkverkeer op te leveren. Hierbij is 100% netwerkverkeer gelijk aan het versturen van alle update informatie naar iedere federate (broadcast).
Bij receiver based filtering kan een verdere reductie bereikt worden, afhankelijk van de "diepte" of de gedetailleerdheid van de "interest"-omgeving. Bij een diepte 3 wordt een 40% reductie bereikt, bij een diepte 5 wordt een halvering van het netwerkverkeer bereikt. Het theoretisch haalbare is een reductie met 55%.

5. SEDRIS

In september '94, mede voortkomend uit de werkgroep "Simulated Environment" van de DIS Workshop, is een project gestart met als doel om ook standaardisatie te bereiken in de representatie van de synthetische/virtuele omgeving waarin de gedistribueerde simulatoren functioneren (terrein, atmosfeer, water).

Voor de bevordering van de interoperabiliteit (en een 'fair fight') tussen de verschillende simulaties, is niet alleen standaardisatie noodzakelijk in het berichtenverkeer tussen de simulatoren (DIS/HLA), maar moeten ook de interne data bases die de fysische aspecten van de werkelijke wereld (omgeving) specificeren, zoveel als mogelijk, onderling consistent, compleet en ondubbelzinnig zijn. Uiteraard geldt dat voor de (terrein) data bases voor de zichtsystemen in simulatoren, maar o.a. ook voor andere sensoren (warmtebeeld, radar, laser) en de data bases waarmee Computer Generated Forces (CGF) programma's werken.
Eerdere pogingen tot een open standaardisatie (bijv. Project 2851, SIF, SIF++) hadden, althans vanuit het gezichtspunt van interoperabiliteit, niet het gewenste resultaat. Het project "Synthetic Environment Data Representation Interchange Specification" (SEDRIS) biedt meer perspectief.

De doelstellingen van SEDRIS zijn:
- het vastleggen van de complete set van data-elementen en geassocieerde relaties die nodig zijn om de omgeving volledig te representeren;
- volledige ondersteuning van de diverse typen simulaties, zoals CGF, bemande en visuele systemen, sensorsimulaties;
- een standaard data uitwisselingsformaat en -mechanisme te verschaffen, welke zo compleet als mogelijk is, zonder verlies van detail-data.

De aanpak van het projectteam (een negental individuele deskundigen, met minimale commerciële bindingen) is, om eerst een goed en volledig **data-model** te ontwikkelen en daarop gebaseerd, een compleet **data interchange format**. Essentieel is daarbij de tussentijdse terugkoppeling van de (data base tools)-industrie door middel van gecontracteerde prototyping met het data-model en met 'Read- en Write-APIs'.
Een en ander zou in 1998 tot een eindresultaat moeten leiden.

6. Conclusies

- Samen met de Annex is de IEEE 1278.1: Standard for Distributed Interactive Simulation - Application Protocols een tamelijk complete set van protocollen om (real-time voor menselijke perceptie) de gebeurtenissen in een synthetisch/virtueel gevechtsveld te beschrijven en de interacties tussen gesimuleerde wapenplatformen te specificeren. Op een aantal protocollen dient de kennis en ervaring nog verdiept te worden.

- HLA is een hot topic. Het moet de opvolger worden van bestaande standaarden zoals DIS en ALSP. Gebruikers uit de verschillende domeinen zijn tevreden over de HLA-functionaliteit maar ontevreden over de performance van de eerste implementatie.

- De overgang van DIS naar HLA zal een groeipad zijn.
  Aangezien de toekomst van gedistribueerde simulatie nog niet duidelijk is, is het verstandig nieuwe applicaties te abstraheren van deze turbulentie. Dit is mogelijk door een tussenlaag (ook wel 'middleware' of 'abstraction layer' genoemd) te gebruiken die voor de eerstkomende jaren een DIS-compliant interface biedt en later ook een HLA-compliant interface.

- Bij het huidige ontwerp van de RTI is minimaal aandacht besteed aan de onderliggende netwerklaag. Er zijn hiervoor geen interface specificaties opgesteld. Toch zou de RTI-communicatie via vele verschillende fysieke media/-communicatielagen moeten kunnen lopen (b.v. geheugenkoppeling, ATM, ISDN, Ethernet).

- Los van de technische pro's en contra's van HLA versus DIS zal een van de repercussies van het DoD-mandaat zijn, dat op termijn de industriële ondersteuning van de DIS IEEE 1278 standaarden zal gaan wegebben door het wegvallen van een belangrijke markt in de toepassing ervan. Voor (simulatie)systemen met een gefixeerde omvang (zonder geplande groeipotentieel na in gebruikname) behoeft dit minder een probleem te zijn; mèt (al dan niet geplande) groeipotentieel wel.

- Naast de protocol- en architectuurstandaarden (DIS/HLA) ten behoeve van interoperabiliteit van simulaties, zijn standaarden voor de beschrijving en representatie van de synthetische omgeving van belang. In dat verband biedt het SEDRIS-initiatief meer perspectief dan eerdere (te beperkte) pogingen. Ook op dit gebied ware de kennis en ervaring te verdiepen.

7. Afkortingen

ALSP	Aggregate Level Simulation Protocol
AMG	Architecture Management Group (van HLA)
API	Application Programming Interface
ARPA	zie DARPA
ATM	Asynchronous Transfer Mode
CCTT	Close Combat Tactical Trainer
CORBA	Common Object Request Broker Architecture
DARPA	Defense Advanced Research Projects Agency (US)
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office (US)
DoD	Department of Defense (US)
FAQ	Frequently Asked Questions
FOM	Federation Object Model
FRED	Federation Required Execution Details
HLA	High Level Architecture
IDL	Interface Definition Language
IEEE	Institute of Electrical and Electronics Engineers
IFF	Identification Friend or Foo
IP	Internet Protocol (RFC 791)
ISDN	Integrated Services Digital Network
IST	Institute for Simulation and Training, University of Central Florida
M&S	Modeling and Simulation
ModSAF	Modular Semi Automated Forces
MS	Microsoft
OMT	Object Model Template
PDU	Protocol Data Unit
PnP-FOM	Plug-and-Play FOM
RFC	Request for Comment (Internet standaard)
RID	RTI Initialization Data
RITN	Real-time Information Transfer and Networking
RTI	Run Time Infrastructure
SAC	Standards Activity Committee
SEDRIS	Synthetic Environment Data Representation Interchange Specification
SIMNET	SIMulator NETwork
SOM	Simulation Object Model
STOW	Synthetic Theatre of War
STGVIP	Special Task Group: Vision Implementation Plan
TCP	Transmission Control Protocol (RFC 793)
TCSEC	Trusted Computer Security Evaluation Criteria
UDP	User Datagram Protocol (RFC 768)
VV&A	Verification, Validation & Accreditation

7. Ondertekening

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Bijlage A Memorandum of the Under Secretary of Defense for Acquisition and Technology

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SEP 10 1996

ACQUISITION AND
TECHNOLOGY

MEMORANDUM FOR: SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
ASSISTANT SECRETARIES OF DEFENSE
GENERAL COUNCIL OF THE DEPARTMENT OF DEFENSE
INSPECTOR GENERAL OF THE DEPARTMENT OF DEFENSE
DIRECTOR, OPERATIONAL TEST AND EVALUATION
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTOR OF ADMINISTRATION AND MANAGEMENT
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: DoD High Level Architecture (HLA) for Simulations

References: (a) DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management," January 4, 1994
(b) DoD 5000.59-P, "DoD Modeling and Simulation Master Plan (MSMP)," October 1995

Under the authority of reference (a), and as prescribed by reference (b), I designate the High Level Architecture as the standard technical architecture for all DoD simulations.

The baseline HLA is defined by three inter-related elements: HLA Rules Version 1.0 (v.1.0), HLA Interface Specification v.1.0, and HLA Object Model Template v.1.0. The evolution of the HLA will be managed by the DoD Executive Council for Modeling and Simulation (EXCIMS) through its Architecture Management Group (AMG). This structure provides a means for the DoD Components to identify and address any emergent issues in subsequent refinements to the HLA. Compliance with the HLA does not mandate the use of any particular implementation of supporting software such as the Runtime Infrastructure.

DoD Components shall review all of their simulation projects and programs by the second quarter fiscal year (FY) 1997 in order to establish plans for near-term compliance with the HLA. The Department shall cease further development or modification of all simulations which have not achieved, or are not in the process of achieving, HLA-compliance by the first day of FY 1999, and shall retire any non-compliant simulations by the first day of FY 2001. EXCIMS is to monitor progress and advise me if any emergent events affect their viability.

To monitor compliance with the HLA, the DoD Components shall submit an initial report to the Defense Modeling and Simulation Office (DMSO) by June 30, 1997, which summarizes their HLA-compliance intentions for each simulation the Component owns or sponsors, organized into three categories:

- HLA-compliance actions initiated immediately
- HLA-compliance actions initiated at a specified future date
- no HLA compliance planned (thus requiring eventual retirement or a waiver)

The DoD Components shall submit periodic updates to these initial reports as required to ensure their accuracy and completeness. DMSO shall establish a mechanism to provide for formal certification of compliance and shall provide me with periodic reports on the Department's progress towards compliance with the HLA.

If a Component believes it is impractical for a simulation to comply with the HLA, or that HLA-compliance cannot be achieved in a timely manner, it may submit a waiver request to the Director of Defense Research and Engineering, the Chair of the EXCIMS. In consultation with the EXCIMS and its Training, Analysis, and Acquisition Councils, I will then decide if an exception to the HLA-compliance requirement is warranted, and if so, the form of that exception.

This mandate for HLA-compliance supersedes all previous requirements for DoD simulations to comply with other simulation standards such as Distributed Interactive Simulation or Aggregate-Level Simulation Protocol. It is expected that new industry standards to support the HLA will emerge. In consultation with the EXCIMS and its AMG, I will evaluate the suitability of such standards for the Department as they are established.

The DoD point of contact for the HLA is the Defense Modeling and Simulation Office at (703) 998-0660 or hla@dmso.mil. The HLA documents are available at http://www.dmso.mil/.

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Bijlage B DIS++/HLA Frequently Asked Questions

DIS++ / HLA Frequently Asked Questions
Last updated April 22, 1996

The following list of questions and answers is provided in response to inquiries from the 14th DIS Workshop.
Responses to the questions have been prepared through the coordinated efforts of the Workshop Steering Committee and the Defense Modeling and Simulation Office (DMSO).
This list of questions and answers is intended to serve the following purposes:

a. Provide a consistent baseline of information regarding the current and future direction of Workshop and DMSO activities.
b. Build a common understanding and support within the M&S community for the Workshop purpose and objectives.
c. Provide the best information at the time of publication. New questions and revisions to answers may occur as results of on going activities reach completion.

Comments regarding this list may be provided through the DIS-STD-STGVIP reflector. See answer to question 43.

HLA FAQ

1. What will be included in the baseline definition of HLA? When will it be available?

ANSWER: The baseline definition of the HLA is due to be released in August 1996, at the end of the prototyping period. It will include a capstone description of the HLA (a top-level summary of the basic architecture structure), the HLA rules (underlying technical principles), the HLA Interface Specification between the RTI and the federates, the HLA Object Model Template, and an HLA Glossary. Accompanying the release of the baseline definition will be an initial set of supporting documentation, which will include descriptions of the HLA federation design and execution process, common test procedures, a security architecture for HLA, time management functions under the HLA, declaration management functions, use cases based on the AMG prototyping experiences, and other technical documents.

During the prototyping process, the AMG has developed prototype software for the HLA Runtime Infrastructure (RTI), the distributed operating system for an HLA federation. This has been produced under a spiral development scheme, with sequential releases of versions of the RTI software to the AMG members for testing in prototype federations ("proto-federations"), with feedback to the RTI developers folded into the next iteration and subsequent release. RTI version 0.3 is due to be released on 30 April, and version 0.4 on 15 July.

2. What is a federation? What is a FOM? What is FRED?

ANSWER: A federation under the High Level Architecture (HLA) for modeling and simulation is a named set of interacting federates (simulations, C4I system interfaces, data collectors, etc.), with a common federation object model, and supporting Runtime Infrastructure software, that are used as a whole to achieve some specific objective.

A Federation Object Model (FOM) is an identification of the essential classes of objects, their attributes, associations, and interactions that are supported by a federation. The FOM is like a "contract" between the federates, describing the type of data they agree to share through the RTI during a federation execution. This data is specified in a manner prescribed by the Object Model Template, a tabular format which includes an object class structure, interactions, attributes, and a data dictionary.

As shown in the Federation Development and Execution Process diagram on the DMSO Web pages (http://www.dmso.mil), the Federation Required Execution Details (FRED) are used in the preparation of a Federation Execution. FRED data is drawn from

* the FOM
* federation common components
* scenario information
* management requirements
* execution environment

FRED data is recorded in a specific format to be defined by the federation developers. This data will be used to supply information to the RTI Initialization Data (RID), to the Federation Test process, and to the federation execution. Any of the customers of FRED data may further reduce the data to a form more suitable for efficient runtime execution.

3. Will HLA be more than a software interface architecture?

ANSWER: The HLA is more than an interface specification. It also prescribes an object model template for documenting the objects, attributes, and interactions which will be exchanged during a federation runtime execution, and a set of HLA rules or underlying technical principles which prescribe certain functionality for both federates (simulations) and federations. In addition, the HLA specifies a Runtime Infrastructure (RTI), in effect a distributed operating system, which provides, through common software, certain services which formerly were the responsibility of the individual simulations.

4. Is HLA more than an ALSP upgrade?

ANSWER: Yes. Both ALSP and DIS have been successful in the application areas for which they were designed. The HLA is an attempt to capture the best ideas derived from experience with both ALSP and DIS, but with an eye to applying M&S to a broader set of applications, with increased potential for interoperability of different simulations and reuse of simulation components. The HLA is being designed to support a wider range of DoD M&S applications with more functionality than either ALSP or DIS alone.

5. What does HLA add to current ADS/DIS capabilities? Have the additional capabilities been demonstrated?

ANSWER: Currently, DIS is designed to support realtime, platform level simulations. HLA provides an added set of services to apply to a broader set of applications. These include time management services (for logical time simulations), declaration management services (for larger scale applications), and object ownership services (for added functionality). These are all services designed to support a wider range of users than currently supported by DIS technology, but who are seen as eventual users of future DIS++ as laid out in the DIS Vision. The additional functionality and interoperability provided by the HLA is being demonstrated through a series of prototype efforts under the direction of the DoD Architecture Management Group (AMG).

6. When will a design document and functional description be available for the RTI?

ANSWER: A top-level functional description of the prototype RTI was presented by members of the RTI development team (from Lincoln Lab and Mitre) at the 14th DIS Workshop. Copies of the papers and briefing charts are available on the DMSO HLA pages on the World Wide Web. Beyond the prototype stage, the basic design document and functional description for the reference implementation of the RTI (version 1.0) is expected to be developed following the baseline HLA definition release in August.

7. Is the RTI open? How do I get a copy of the RTI? When will it be available outside the proto-federations? What will it cost to purchase? What will it cost to run?

ANSWER: Prototype RTI software is being developed in support of the HLA definition process. The current RTI prototype is being used with a range of DoD simulations in a set of prototype federations ("proto-federations") directed toward verifying and refining the initial HLA definition. A baseline definition of the HLA will be released in August 1996, based on the work of the AMG. This baseline will be augmented by a set of supporting documents (test procedures, security architecture, development process description) which will be released by October. HLA supporting software, including the RTI, developed during the prototyping period will be updated to conform to the baseline HLA definition and made available for more general distribution and use as soon as possible following the August baseline. Plans are now being made for this release, and once they are in place we will publish them through the AMG and the DMSO home page. It is envisioned that this version will be government-owned freeware, available at no cost for use in adapting and developing new HLA-compliant simulations.

8. What about the latency in the RTI (especially CORBA)? Can it support real time simulation?

ANSWER: It is recognized that RTI latency and throughput are critical issues, particularly for real-time and faster-than-real-time simulations. A key part of the design process for the prototype RTI involves assessing the performance of the selected CORBA implementation with respect to these factors. Three of the prototype federations helping to refine the HLA include federates who previously used DIS, and they will be paying close attention to latency. Where CORBA performance is found to be inadequate, other mechanisms involving the direct use of UDP or TCP/IP protocols are being employed. The prototype RTI is intended to provide us the experience, test results, and insights necessary to allow the development of an operational RTI which meets user needs. The prototype RTI is leveraging techniques developed under the ARPA Synthetic Theater of War (STOW) program, and represent the most advanced approaches to large-scale distributed simulation applications demonstrated to date.

9. Will the RTI require an executable like CORBA? What about the cost of CORBA? What about the stability of the CORBA standard?

ANSWER: As indicated in the response to Question 8, decisions about how various RTI services are implemented are being made on a case-by-case basis, depending on the measured capabilities of the current CORBA software in the context of the overall RTI design. The RTI development team has adopted a commercial software development tool (ORBIX™) to produce the initial prototype of the RTI software. It presently is based on CORBA 1.0, with some custom modifications to enable multicasting. This choice was made to implement the widest range of RTI services as quickly as possible. It is felt that CORBA 2.0

will remove the dependence on specific vendors and will have the necessary stability to be used in RTI version 1.0. When the initial prototype implementation is completed with RTI version 0.4, an assessment will be made based on the RTI's then-current configuration. Possible recommendations include further development based on the initial model, the incorporation of some other CORBA implementation based on alternatives then available, or even development not using a commercial CORBA product. In many respects, this will represent a classic "make vs. buy" analysis. It is too early to project the outcome of this analysis, much less to speculate on the cost of off-the-shelf software components at that time.

10. What is the RTI communications layer? Where does one get information on the communications layer?

ANSWER: The RTI prototype implementation is using standard protocols such as UDP or TCP/IP, RSVP, and NTP. A "virtual network" layer is being implemented to isolate the RTI functions as much as possible from changes in the underlying communication mechanisms (such as IP, native ATM, or shared memory). The implementation is employing a number of techniques developed under ARPA's Real-Time Information Transfer and Networking (RITN) effort, such as the Consistency Protocol, to maintain overall distributed database consistency without demanding reliable delivery of each simulation state update. The results of this effort on the RTI prototype will be documented and should be available by October.

11. Will HLA be sufficiently tested before transitioning to it?

ANSWER: The HLA is being tested prior to the formal baseline definition through a series of prototypes. These provide a variety of conditions and test scenarios which address a range of potential DoD M&S applications. The AMG is developing common interface test procedures, which will be benchmarked against the experience gained through the AMG proto-federations. In all, more than 25 separate simulations and simulators ("federates") are being adapted or built to participate in the proto-federations. This will provide an initial cross-section of experience across a number of M&S application areas, from training to analysis to engineering models. Performance analysis of prototype implementations of the RTI and proto-federations will be conducted to develop necessary performance specifications for future infrastructure (e.g., RTI) development.

12. What type of test will be used to evaluate the proto-federations and the RTI prototype?

ANSWER: Performance testing will take place in different proto-federations, using a common performance measurement framework and a common interface test procedure. Each proto-federation is developing its own test plan for assessing the HLA for applicability to their applications. Feedback from the proto-federations on the testing procedures will be used to revise the test procedures as a supporting document to the HLA baseline definition. Emphasis will be placed on learning where within the proto-federations various latencies occur, as well as where throughput bottlenecks occur. This information will be used in recording "lessons learned" and in formulating recommendations for subsequent RTI development. In terms of the RTI, tests will focus on communications efficiency (in terms of minimizing communications overhead and communications redundancy), end-to-end latency, and overall throughput (attribute updates per second). Where attribute update filtering is employed, it is desirable that the RTI deliver all the relevant updates to the subscribing federates, with a minimum of extraneous or irrelevant information that must be discarded at the destination.

13. Will the HLA be language neutral? Will the RTI? Will we always have to use C++?

ANSWER: The HLA will be language neutral, since it is an architecture, independent of implementation language. In terms of the simulations within a federation, the only requirement is that they be described in terms of objects, attributes, and interactions, and that it conform to a standard (common) API. While it is an option for simulation developers, there is no intent or implication that the simulations must be implemented in an object-oriented programming language. The RTI is indifferent to how the federate-level services are implemented. In fact, current proto-federations refining the HLA under the AMG have been implemented in a wide range of programming languages, to include C, C++, Ada, MODSIM, Smalltalk, and even FORTRAN.

14. Will multiple federations reduce interoperability?

ANSWER: The HLA explicitly addresses interoperability among simulations in a single federation, not interoperability between distinct federations. However, the following implicit factors will encourage interoperability between federations.

* The DIS++ Protocol Catalog will provide standard attribute and data definitions for all federations to use in their FOMs. All federations will be expected to use these standard definitions to the maximum extent possible. This will ensure that common attributes (e.g. location, orientation) have common representation in different FOMs.

* DoD will maintain an on-line library of FOMs in the Modeling and Simulation Resource Repository (MSRR). Such FOMs, or components of them, will be used to build new FOMs, thus encouraging interoperability between generations of FOMs.

* At the 14th DIS Workshop, it was suggested that DIS++ develop core or "starter" FOMs that contain a standard set of attribute and data definitions for a particular simulation domain. Individual federations would use these as the basis for develop FOMs for specific federations. This will encourage common data representation between federations in the same domain.

* The architecture does not encourage or discourage the use of specific FOMs. The idea of a set of reusable "master" FOMs is worth pursuing.

15. Where will authority to change HLA reside? How is the DIS Workshop going to affect the development of HLA when it is being handed over to a contractor to develop?

ANSWER: The HLA is not being handed over to a contractor to be developed. The HLA has been developed as a DoD product, and as such, during the baseline development, authority for changes resides at DoD. The body empowered to develop the HLA is the DoD Architecture Management group (AMG). The membership of the AMG was set by the DoD Executive Council for Modeling and Simulation (EXCIMS), based on nominations from the Services and DoD Agencies involved with M&S technology. Aside from individual name changes due to personnel changes in organizations, during the prototyping period (at least through August 1996), membership of the AMG is fixed. The current roster of AMG members is viewable on the DMSO Web pages (http://www.dmso.mil/wrkgrps/amg/amgmem.html).

With the development of DIS++, certain components of the HLA (e.g., the Interface Specification, the Object Model Template, and the Protocol Catalog) are expected to be standardized through the DIS Workshop process. Once they become standards, the DoD

will adopt these industry-based standards and future changes to the standards will become the responsibility of the standards body.

Common supporting software components (e.g., versions of the RTI, HLA interface modules) may be procured commercially, although they will be based upon government specifications, considering the work of the standards body.

16. Is the HLA intended to be an IEEE standard?

ANSWER: The DIS++ Steering Committee will form working groups that will develop draft IEEE standards based on the baseline HLA definition. These documents will be balloted to become an IEEE Standard.

17. What will be standardized within HLA? How will the RTI be configuration managed and controlled, and by whom?

ANSWER: It is expected that certain components of the HLA prescribed in the baseline definition will be standardized. The prototype RTI implementation presently being tested is being developed and configuration managed by a Lincoln Laboratory/Mitre Corporation team under the guidance of DMSO and the AMG.

18. Where is the master document?

ANSWER: DMSO currently maintains the HLA documentation. All HLA documentation is available for viewing and downloading via the DMSO home page on the World Wide Web (http://www.dmso.mil/). This includes the following:

HLA Management Plan (version 1.6)
HLA Interface Specification (version 0.4)
HLA Application Programmer's Interface (API) (version 0.2)
HLA Object Model Template (version 0.2)
HLA Time Management Design Document (version 0.21)
HLA Interface Specification Test Procedures (draft)
Various supporting briefings, both technical and programmatic

Text documents are currently stored as Microsoft Word documents and as Adobe Portable Document Format (PDF). Briefings are generally in Powerpoint and in PDF, although several are viewable directly onscreen as well. In addition, at the bottom of most of the DMSO HLA Web pages there is an e-mail address (hla@msis.dmso.mil) for submitting comments or questions about the contents of the pages. This address connects to personnel at DMSO who review the questions and either answer directly, or pass the inquiry to the proper person to provide a response.

19. What is the schedule for HLA? What is the time table to have all sims running HLA? What is the transition plan for current DIS users?

ANSWER: The DoD Modeling and Simulation Master Plan calls for a "review [of] all ongoing DoD M&S projects and/or programs by second quarter FY 1997 for feasibility of immediately adopting the HLA. If not immediately feasible, these reviews shall establish the date by which each program shall comply. If a specific M&S project and/or program is unable to comply with the HLA, the developing Component must report the reason(s) for non-compliance to the DDR&E."
See answer to Questions 1, 6, and 7. [DoD 5000.59-P]

20. Does the DoD mandate to use HLA apply to legacy models? When are models required to use HLA?

ANSWER: The approved DoD Modeling and Simulation Master Plan, under Sub-Objective 1-1, prescribes the establishment of a common high-level simulation architecture "to which simulations developed by particular DoD Components or functional areas must conform." The Master Plan requires DoD components review their ongoing M&S programs by second quarter FY97 for feasibility of immediate HLA compliance. Legacy systems (i.e. those existing before the baseline definition of the HLA is promulgated) will be examined on a case by case basis. Basically, if a simulation expects to interoperate with another simulation in a meaningful way once the HLA is set in place, then the simulations will be required to become HLA compliant. If the simulation has no reason to interoperate with another simulation (i.e. it is fully a "stand-alone" simulation), then it could potentially operate without the HLA, although it would then have to provide for itself all the common infrastructure which the HLA makes available to simulations. We expect that the cost, schedule, risk, interoperability, and reuse benefits which HLA compliance offers will be a compelling incentive for all Program Managers to adopt the HLA.

21. How will DoD handle converting simulators from DIS to DIS++ so that simulators can talk to each other (i.e. some simulators will be using DIS and some using DIS++)?

ANSWER: Under the HLA, each simulator is considered a federate. As such, bringing a simulator into compliance with the HLA will be treated just like any other federate. Current proto-federations involve both new and DIS-compliant simulators, so relevant data will be available soon. We expect commercial DIS to DIS++ adapters will emerge in the near future. See also questions 19 and 20.

22. How much will it cost to convert legacy models to HLA? What are the potential sources of funding to convert legacy models to HLA?

ANSWER: The cost to convert legacy models to HLA will vary on a case by case basis, depending on a number of factors such as the original engineering design of the model, the purpose for which it is being adapted, and the schedule desired for the adaptation. Under the HLA prototype effort, roughly 25 individual simulations (or "federates") are being designed or adapted to the HLA. This provides a number of case studies which will allow a better assessment of the potential costs involved with HLA adaptation. The source of funding is again determined on a case by case basis.

23. Won't the overhead required for HLA be excessive for small exercises?

ANSWER: There is no reason to believe that the overhead for small exercises will be "excessive". The proto-federations testing the HLA during the prototype development stage (prior to the release of the baseline definition in August) would all fall in the category of "small exercise" by DIS standards, so definitive data on this issue should be available soon. See also the answer to question 8.

24. How will time synchronization issues be resolved?

ANSWER: The HLA Time Management Design Document (available on the DMSO Web pages) details a number of time management services which are reflected in the latest version of the HLA Interface Specification. These services should provide the mechanism to support meaningful interactions among federates with different time management require-

ments. These services will all be tested by the HLA proto-federations prior to the release of the HLA baseline definition.

The federates and the RTI both rely on the existence of wallclock time that is provided by a service external to the RTI (and federate). Wallclock time is assumed to be available on each computing platform that supports a component of the RTI or a federate. The wallclock time access mechanism is not defined by the HLA. A given implementation of the RTI and all the federates that use that RTI must agree on the source of wallclock time for each type of computing platform and the mechanism used to coordinate wallclock time among all cooperating platforms. The mechanism and the degree of coordination are potentially important to the success of a given federation but are not constrained by the HLA specification.

25. What about security in HLA?

ANSWER: Security issues, particularly multi-level security in distributed exercises, transcends the architecture. DMSO is sponsoring the development of a security architecture as part of the HLA development program. The documentation which will support the HLA baseline definition will include a reference security architecture. A preliminary description of that architecture was presented at the 14th DIS Workshop, and it is expected that such technical interchanges will continue. At least one of the HLA proto-federations will perform classified exercises, and the goal is to define the HLA such that it does not preclude whatever is required to address multi-level security issues.

26. How will data loggers/stealths/etc. function in a multi-cast environment?

ANSWER: While multicast is available under IEEE 1278.2 profile 2, DIS exercises to date have used broadcast transmission services so data loggers and stealths are always receiving a stream of data on all players at all times during the exercise. When multicast is used, this will not be the case.

One of the Simulation Management PDUs in DIS 2.x commands simulations to store given data locally and transmit it to central loggers when commanded at the end of the exercise. Under DIS++ multicast operations, loggers will probably be assigned to log data on the multicast groups that have been subscribed to by the simulations physically located near it and to transmit this data to a central logger at the end of the exercise for merging and filtering. The stealth viewer can subscribe and unsubscribe just like any other simulation. Naturally, there will be some redundant data and it will have to be filtered out by the central logger. An HLA federation could have one data logger, but this may not be efficient in most cases. More likely, a data logging function will have to collect and collate data from multiple sources. Other more elegant solutions than the one described above are likely to be developed over time. More work is needed in this area, and the Synthetic Theater of War (STOW) program (one of the members of the AMG) is actively pursuing technical solutions.

DIS 2.x

27. Why are current DIS systems being referred to as legacy systems?

ANSWER: The term "legacy system" is applied to any simulation which will be designed prior to the baseline definition of HLA, and which is not designed to take into account the HLA rules,

interface specification, etc. It is intended to identify those DoD simulations which may require some degree of modification prior to being incorporated into an HLA federation.

28. Will we continue to support DIS? For how long? Will we add to 2.x standards while DIS++ is being planned?

ANSWER: Any document submitted and approved as an official IEEE standard has a validity period of five years from the date of approval. At the end of the validity period the document must be revised, reaffirmed by ballot, or withdrawn. The workshop process currently has three documents, IEEE 1278-1993, 1278.1-1995 and 1278.2-1995, which require this nature of support. In addition, the Protocols Working Group currently has under development an extension to IEEE 1278.1-1995. This extension will be completed through the workshop process, and should complete the balloting and IEEE approval process by mid-year 1997, at which time the five year validity period will begin for this document. The activity in support of maintaining validation of our IEEE standards constitutes one level of continued support for DIS standards needed from the workshop.

The availability of funds (see answer to question number 22) and the support available to transition HLA-legacy systems from DIS to HLA-based systems will define the amount and extent of new DIS standards development that will continue. The requirement is that all ongoing DoD M&S projects will be HLA compliant. DIS++ will develop and maintain the current protocol standards 1) until the DoD applications using them can transition to HLA, and 2) while needed by organizations outside of DoD.

29. What happens to my current investment in DIS 2.x?

ANSWER: The global transition from DIS 2.x to an HLA compliant structure will be a process which occurs over time. Depending upon the timetable within the community with which you interact or federate, you may get appreciable benefit out of your investment prior to conversion. Your future investment decisions need to be influenced accordingly.

30. My company has two very specific purpose type simulators which have been actively used in recent DIS demonstrations and exercises. Will we be excluded from further participation because we do not have, and do not have the internal resources to develop, an RTI interface?

ANSWER: There will continue to be DIS exercises run during the period of transition. Also, there are DIS to HLA conversions being developed to support DIS and even SIMNET-based federates in the current HLA proto-federations, which suggest that commercial products will become available to ease the transition from DIS to HLA for companies such as yours. See also question 21.

31. What will happen to all the DIS tools that have been developed (i.e. XCIU, Data loggers, data analysis tools, etc.)? Who will pay to have these converted to HLA?

ANSWER: Modification of some existing tools and development of new ones has already begun as part of the work within the HLA proto-federations. However, future users of the HLA will continue to have to support the development of the full complement of tools required for HLA, just as they did to support the maturation of DIS. Much of what has been developed for DIS will ease the way for developing similar capabilities to support the HLA.

32. My simulator is about to start testing by means of the DIS Test Suite. Will there be any significant value in passing the tests of this test suite in the new HLA-based paradigm?

ANSWER: The primary value will be in the ability it will afford to be able to participate confidently in such DIS exercises as may occur before you are called upon to federate in an HLA environment. Passing the test also provides evidence that your simulator is a candidate for possible inclusion in future HLA federations.

33. Should I finish my 2.x document?

ANSWER: DIS has concentrated on real-time virtual and live simulations at the tactical level in the past. DIS++ will expand to serve other communities as well. During the transition period to DIS++, the real-time virtual and live simulations will continue to operate and can benefit from the DIS 2.x documents currently being developed. In addition, most of these simulations will continue to operate when modified to implement DIS++ principles. Consequently, the information contained in the DIS 2.x documents may be useful in the DIS++ arena.

If a document is near completion, it should be finalized and considered as a resource for the development of DIS++ documents to be started soon. If the document is longer term, then the DIS++ Steering Committee will consider it for expansion and modification to incorporate DIS++ concepts.

DIS++

34. What is DIS++? What are the differences between HLA and DIS++? Is DIS++ an implementation of HLA?

ANSWER: As stated in the registration handout at the 14th Workshop, the name DIS++ has been chosen to communicate the essential objective of expanding the standards development activities to include both the High Level Architecture and other members of the modeling and simulation community. DIS++ refers to the evolution of the DIS standards to cover areas of modeling and simulation identified in the DIS Vision document but not addressed in the current standards (e.g. event driven simulations, analytic models, interfaces to operational systems). HLA is an explicit architecture being developed, and currently owned, by DoD to provide a common framework for the development of all DoD modeling and simulation. To prove that the HLA is a viable concept, DoD is sponsoring the development of prototype implementations of the HLA. See answers to Questions 1, 3, 4, 5, 11, and 12.

DIS++ standards development will be conducted by the standards development organization and processes resulting from implementing the plan prepared by the current Special Task Group for Vision Implementation Plan (STGVIP) . The DIS++ standards workshop will assume responsibility for standardization of the main components of the baseline HLA and other standards important to the M&S community as part of the normal standards development process. The DIS++ standards body will also expand the DIS DD/PC (Data Dictionary/Protocol Catalog) to include common data structures needed by DIS++ applications. This expanded product will called simply the DIS++ Protocol Catalog. See answers to questions 16, 17, 18, 36, and 41.

35. Is HLA or DIS++ a protocol?

ANSWER: HLA is an architecture, defined by an interface specification (with corresponding API), an object model template, and a set of underlying technical principles (rules). DIS++ is a set of standards supporting this architecture. It is envisioned that, during the design and implementation of an HLA federation, certain resources, such as a Protocol Catalog (an extension of the DIS Data Dictionary/Protocol Catalog) will be available through on-line repositories.

36. Is DIS 3.0 = HLA? Is there going to be a DIS 3.0?

ANSWER: There will not be a DIS 3.0, in the sense of another DIS generation between the current 2.x standard and the HLA compliant version. Future evolution of DIS is denoted DIS++. The architecture adopted for DIS++ is HLA.

Questions & Comments Related to VIP and Standards

37. Don't you think the stated schedule for reorganization is insane?

ANSWER: No. The revised organization will undoubtedly evolve over time, and it is important that we START the process soon. With the availability of the HLA baseline definition in August, there is an opportunity to begin work at the September Workshop, and we don't want to miss that opportunity. While the details of transition to DIS++ await the recommendations of the STG VIP, the desire is for a close working relationship between the developers of the HLA and the IEEE standards body.

38. Have we given up on the entertainment industry?

ANSWER: DIS and the entertainment industry have many common interests and this area of commonality is growing. Companies and individuals developing VR (Virtual Reality) applications for the Internet are creating a set of standards called VRML (Virtual Reality Modeling Language) to meet their specific needs. There is an overlap in membership between the VRML and DIS communities. VRML and other entertainment industry speakers have participated in the last two DIS workshops. To make the link between the communities a bit more formal, the DIS Coordinating Committee has invited a member of the VRML Architecture Group, the equivalent of the DIS Steering Committee, to be a member of a panel reviewing DIS++ reorganization plans. DoD is also aggressively pursuing opportunities for cooperation with the entertainment industry.

39. Have we backed away from an international standard? Are we targeting ISO with our standards?

ANSWER: No. DIS continues to consider its objective international standards, and the Modeling and Simulation Master Plan calls for the establishment of international standards (e.g. ISO) in addition to IEEE standards. However, going directly to an ISO standard is a lengthy and costly process. Going first to an IEEE standard creates a "fast path" to an ISO standard. The DDR&E also recently invited liaison within NATO regarding the HLA development process. The HLA products are being made available largely through the Internet, which is international in scope. While there are still certain restrictions (external to the HLA development process) which may restrict the unlimited distribution of certain software components, the goal is to make the HLA as widely available as possible.

40. Will we have requisite support for conferences/workshop?

ANSWER: There is strong support for the involvement of the DIS community in the development of the HLA from the highest levels of the DoD. The evolution from DIS 2.x to DIS++ will actually broaden the base of support for the Workshops, since DoD M&S communities which previously were not strongly supported under DIS 2.x will now have a role. This broadening of scope will call for a reorganization of the structure of the workshops, and this will strengthen the standards process. DMSO intends to continue/enhance its financial support to the DIS standards organization.

41. What are the futures of the current workgroups at the workshops?

ANSWER: The current workgroups are oriented around real-time virtual and live simulations at the tactical level. As we expand our goals to serve a broader modeling and simulation community, one option is to simply invite members of these communities to join our current working groups. However, many DIS++ concepts do not fit neatly into the current workgroups.

The DIS Steering Committee voted to reorganize the workshops around the products that will be needed to implement DIS++. We will be forming workgroups to standardize these products. Naturally, many DIS 2.x goals will still be goals in DIS++. Consequently, some of the future workgroups will be similar to the current groups but with a broader mission and new participants.

Current workshop participants should rest assured that there will be ample opportunity to volunteer their time and energy and have an impact on the development of DIS++ products.

Compliance

42. How do we determine compliance?

ANSWER: The DoD M&S Master Plan describes compliance in terms of the High Level Architecture (HLA). The AMG is preparing a definition of HLA compliance as part of the baseline definition. The current thought is that HLA compliance deals with how well a federate handles the functions defined in the HLA interface specification, whether it has an object model in conformance with the OMT, and whether it complies with the HLA rules for federates. This is distinct from Federation testing, which is the responsibility of individual federations. See answers to Qestions 11 & 12. Corresponding compliance definitions and test procedures will be included as an integral part of DIS++ standards development ..

Getting Information and Answers

43. How do we get more information?

ANSWER: Current information about the full range of DoD M&S activities is available on the DMSO home page: http://www.dmso.mil/. Current information on the status and progress of the HLA development is available from the home page or more directly at http://www.dmso.mil/projects/hla. These pages contain literally hundreds of pages of information, both in technical documentation and in briefing materials, describing the vari-

ous aspects of the HLA. At the bottom of most of the DMSO HLA Web pages, there is an e-mail address (hla@msis.dmso.mil) for submitting comments or questions about the contents of the pages. This address connects to personnel at DMSO who review the questions and either answer directly, or pass the inquiry to the proper person to provide a response.

Current information about activities conducted by the DIS Standards Workshop is available at the IST Service Center home page: http://www.sc.ist.ucf.edu/~STDS/ . Information on the status and progress of the Special Task Group Vision Implementation Plan (STGVIP) is available from the home page under Files and Documents (FTP Area with titles.) or more directly at http://ftp.sc.ist.ucf.edu/STDS/stgvip. Comments or questions concerning STGVIP reports and activities may be provided using the DIS-STD-STGVIP reflector. To subscribe to the STGVIP reflector, send an e-mail message to "listproc@sc.ist.ucf.edu". The subject may be anything you wish, but the body of the message MUST have ONLY ONE LINE as follows:

"subscribe DIS-STD-STGVIP First Last" with your first and last name entered in place of First and Last as shown. Do not include the quotation marks in the address or body of the message.

Aside from face to face presentations at conferences such as the DIS Workshop, the best clearinghouse of information on the HLA and STGVIP activities are these pages and reflectors.

Bijlage C DIS++ Transition Frequently Asked Questions (11/96)

Topics

Transition

- Question:
  How long will it take for the dust to settle from around this newborn DIS++ so that we can get on with the detailed business of promoting interoperability and distributed simulation?

  - Answer:
    The Transition Team will stand up SAC and CC by March '97

- Question:
  If I were to develop some novel protocol element for DIS++, I would want as many people as possible to start using it as soon as possible (cf WWW/Java) - this would bring greatest commercial advantage to me in the short term. Will the DIS++ organization help or hinder me in this effort? How would it do so?

  - Answer:
    In general the conference will be an excellent platform for you to publicize your ideas in position papers and expose them to your peers for evaluation and refinement. In addition, DIS++ conferences will have vendor displays where you may demonstrate products, techniques, or ideas. The only limiting factor will be fees and the availability of facilities.
    DIS++ email reflectors will provide another avenue for promulgating products, techniques, and ideas.

- Question:
  Since the purpose of the Transition Team seems to be to determine the future of HLA in terms of the preparation of standards for its use and the policies governing the organization of the federations, shouldn't there be an "Implementation Representative" on the Transition Team? This person would be able to help users in the short term, with lessons learned and to provide a conduit for information exchange between HLA implementers.
  - Answer:
    The purpose of the Transition Team is NOT to determine the future of the HLA (or DIS for that matter). The actual purpose of the Transition Team is to create the workspace (both physical and virtual) for the future HLA and Distributed Simulation work to continue. That future work will include development and ratification of products such as standards, guides, rationale, conference proceedings, etc. The future work related to the development of these products is not going to be accomplished by the Transition Team as a whole; rather, the work will continue to be accomplished by the practitioners, users and theoreticians who have done

so in the past.

However, the work of the Transition Team does play an important role in the development of these products. The conference structure must provide both physical and virtual space for the groups to meet to continue the work of both HLA and DIS, while ensuring that they travel the same path. In addition, space must be provided to allow the users and practitioners to provide inputs on both good and bad past experiences, as well as communicate their needs and corrections for the future.

In addition, the Transition Team will provide for initial Standards Development Groups (SDGs) to carry on with the work in progress done to date by HLA groups and DIS groups, but is not yet in final form. As time progresses, and needs are expressed, additional groups will be formed (and disbanded once work is accomplished) to fulfill the needs expressed by the users.

The Transition Team is not composed of "specialty areas", such as implementation; and there was little or no thought given to the composition of the Transition Team regarding specialty areas. Rather, the Transition Team was chosen from a group of individuals interested in seeing DIS and HLA progress together as complementing, rather than opposing technologies.

For the interim, the users should seek out the past protofederations and experimenters for their lessons learned and guidance for the interim. DMSO is the best place to start for such help. Once the conference takes shape, a space will be provided for the users and implementers to meet with those users of the technology (just as it occurs in DIS). If the need arises for more formal gatherings, either after the initial DIS++ conference, or prior to its inception, a process will be established (by the Transition Team) to allow those meetings to occur.

Again, let me emphasize that the purpose of the Transition Team is to develop the structure of the conference and working teams in such a way as to allow the ongoing HLA (and DIS) work to continue and progress effectively.

Workshops / Conferences

- Question:
  What will future DIS++ conferences look like?

  - Answer:
    - 2 conferences per year (Sept and March)
    - Every conference would include
      - 1 day of User Community Forum
      - 2 days of Specialty Area Forums
      - Reports from the SDGs to the relevant forums
      - TTT formed to address issue

- Question:
  Is the semiannual Orlando gathering, formerly known as "Workshop on Standards for the Interoperability of Distributed Simulations," going to continue to be a Workshop?

  - Answer:
    Whether or not it will be a "workshop" or a "conference" is being debated and whatever choice is made will take into account the concern about getting permission and funding to attend.

- Question:
  If the DIS Workshops end, so ends the EMF group. How do we (as individuals) get from here to the next incarnation? Who will lead the next work group (assuming our projects are accepted)? We had staff support from IST (Dr. Paris). Might that continue?

  - Answer:
    As stated in the VIP, standards groups will receive support from the support group as EMF has in the past. The successor organization, whatever it is called, should start meeting in March.

- Question:
  If the Workshop series ends with the 15th, will it be necessary to attend both its successors -- the conference and the working groups? The reason, of course, is that payers of per diem may be happier paying for working sessions than for conferences, but if truly important things occur at the conference it will be necessary to attend that too.

  - Answer:
    Hopefully, the amount of travel will be no higher than it is now, with standards activity replacing interim meetings. The conference will provide the technical engine, membership and electorate for the standards.

Standards

- Question:
  What is going to be standardized?

  - Answer:
    The HLA IF Spec, and OMT will be the initial new DIS++ standards. A standard for representing the natural environment, SEDRIS, has been identified as a potential standard. A new version of the IEEE 1278.1 standard will be balloted. Other standards will be established as requirements for them emerge from the M&S community through the DIS++ conference. A process for identifying and developing such standards is a key part of DIS++.

- Question:
  How will new people know how to get plugged into the standards development process?

  - Answer:
    The best approach is to get involved in the Workshop Forum(s) of interest to them. These Forums are where new ideas and problem issues are surfaced and debated, and from which proposals for new standards or modifications to standards will arise. Once the CC, EXCOM, and SAC have approved a particular item to become a DIS++ product, there will be additional opportunity to participate. The Forum members will be the primary source to which the Standards Actitvity Committee will come to seek volunteers to write and review the product as the product matures. Each Forum will have an associated email reflector; subscribing to this reflector will automatically enroll a person as a member of that Forum.

- Question:
  Is its focus to remain on standards for interoperability? or is it expanding to include other/different issues (reuse, etc.)?

- Answer:
  The desire is to expand the scope to include other issues as well as "interoperability".

- Question:
  Will there be standardized interfaces to legacy systems?

  - Answer:
    HLA-DIS and HLA-ALSP interfaces have been identified and designed at a functional level. DIS++ standardization of such products is being considered. Such standardization depends largely on requirements that emerge from the M&S community through the DIS++ conference.

- Question:
  Will there be further development /support for the existing DIS standards?

  - Answer:
    Yes. One more revision of IEEE 1278 series will be balloted via the IEEE process. The DoD HLA, and associated DIS++ standards, will supersede the 1278 series over the next few years as the HLA and related standards mature. Further development of DIS-like (e.g. message based protocols) standards will be undertaken as requirements for them emerge from the M&S community through the DIS++ conference.

- Question:
  There appears to be a persistent desire to maintain formal control on the definition and use of DIS++ standards - ie to be official DIS++, your proposals must go through the formally defined procedures. What is the position on control and use of DIS++ standards?

  - Answer:
    Control of DIS++ standards by the organization will extend to their development within the organization and to their advertised use. That is, vendors may not claim that their products are compliant or compatible with DIS++ standards without approval by the DIS++ organization.

    The DIS++ organization is an independent standards development body and a forum for exchange of related information. It cannot require, advocate, or prohibit the use of DIS++ standards in any simulation application. The use or approval of a particular standard in an application will be determined by the policies of the organization responsible for that application.

    The HLA situation is an example. The HLA is being developed by the US DoD with participation by key members of the DIS community. At a time to be determined during the transition period, the DIS++ organization will assume responsibility for maintenance of several key components of the HLA (e.g. Interface Specification and Object Model Template) and will establish them as DIS++ standards. However, the requirement to use these standards in US military simulations will be determined by DoD, not DIS++.

Projects / Groups

- Question:
  What happens to the existing DIS working groups?

- Answer:
  - All existing groups were disbanded as of the 15th workshop (Sept 96)
  - The TT will develop charters for the new Executive Committee, Conference Committee, and Standard Activities Committee will oversee elections before the March Conference
  - New groups will be formed under the new structures
  - Most focus groups will map to User Community Forums
  - Most WGs and SIGs will map to Specialty Area Forums

- Question:
  What will happen to ongoing projects, such as those involved in FDR or protocol writing, and more to the point, our efforts to refine the EMF process descriptions?

  - Answer:
    The Transition Team will oversee any transition groups that are completing tasks.

- Question:
  The EMF group appears to have two projects on the horizon -- the engineering standard (Brett Butler) and the DIS++ process model (Bob Lutz). Do we expect others in the near future?

  - Answer:
    Process and automation discussion and standardization will be increasingly important. Consideration is being given to having a forum to address this area.

DIS FOM

Question:

- An important issue in the transition from DIS to DIS++, is the issue of a DIS FOM. Clearly, it will be very useful, and perhaps necessary, to have an encoding of the DIS standard in OMT format. (In fact, it is my opinion that in a HLA world, DIS is a federation, albeit a big and important one.) We have already been made aware of the existence of several DIS FOMs.

  Can the TT assemble a complete list of DIS FOMs in existence, under construction, or planned, and define their differences?

  - Answer:
    FOMs were derived in part from DIS standard protocols for the Platform, T&E, and JPSD/IEC HLA protofederations. The FOMs are available for examination from those protofederations. No comparison of those FOMs has been made or published.The DIS Protocols WG has embarked on an effort (Richard Schaffer lead) to convert the existing 1278.1 protocols and enumeration data into a DIS FOM (known as the Plug 'n Play FOM). DMSO is cooperating in this effort. The results will be available for examination and discussion at the March 97 conference

- Question:
  Does the TT, the SC, or the larger DIS community have any plans to elevate one of those DIS FOMs, or a combination of them, to the status of standard, i.e. as part of the DIS standard?

  - Answer:
    No serious studies have been conducted, no recommendations have been brought forward, and no decisions have been made regarding the development and standardization of a DIS FOM. However, this is a growing area of interest and will demand attention in the near future.

- Question:
  If so, how will the standard DIS FOM be selected?

  - Answer:
    The issue of FOM standardization depends on what emerges from the M&S community through the DIS++ conference discussions. The community needs to decide whether there is one or a set of FOMs they want to standardize, and if a set what the members should be. Once that is decided, then the DIS++ conference and standards process can be used as appropriate.

- Question:
  Will a standard DIS RID also be constructed?

  - Answer:
    The RID will probably not be a DIS++ standard. The RID is RTI specific. It might make sense to standardize some RID contents across all RTIs or possibly within communities, but in addition to some standard information, a particular RTI may require some information for optimization, etc. Hopefully, even if we do not standardize RID information, a RID Data Interchange Format (DIF) might become DIS++ standards so tools could be developed which could produce the information required by a RID and then a specific RID reader could consume the information.

- Question:
  What will be Standardized? FOM's? SOM's? OMT?, HLA itself?

  - Answer:
    The HLA interface, the OMT and the architecture (possibly containing the rules) will be the first initial set of HLA related DIS++ standards. SOMs will probably not become DIS++ standards, but it is likely that community FOMs might emerge from the M&S community through the DIS++ conference and be considered as DIS++ standards.

OMT

- Question:
  Is the OMT complete? To the level of Balloting?

  - Answer:
    The OMT is not complete in the absolute sense since there are several additions to it being explored by the DoD AMG and as the larger community begins to use it, they will find additional improvements worthy of standardization. On the other hand, what is there has been used by the protofederations and therefore has enough maturity to initiate the standardization process.

- Question:
  Has it been interpreted by people who did not write it?

  - Answer:
    The users in the protofederations were not the authors of the OMT. The protofederations all had representatives on the AMG OMT working group, and therefore the results of their experience using the OMT were included in the 1.0 version approved by the AMG.

Community

- Question:
  What are we (the DIS ++ community) trying to achieve?

  - Answer:
    The fundamental purpose for the reorganization of the DIS workshop is to expand the scope of the DIS standards to serve M&S communities outside of the original real-time platform level simulations that were the origins of DIS. To do this DIS++ will embrace the DoD HLA and develop standards for it. The HLA provides a general structure that will permit different kinds of simulations to interoperate. The DIS++ conference or workshop will have some education aspects. The major user (DoD) will have it's own outreach and training.

- Question:
  How are the people in the DIS community going to transition to the new way of thinking? This includes end users as well as developers and standards-setters. The DIS community is many times bigger than those who attend the workshops.

  - Answer:
    The DIS++ Outreach will be proactive. DIS++ will encourage participation from other M&S communities via an outreach program that will:

    1. invite key individuals from other professional/standards bodies to participate on DIS++ committees
    2. encourage the formation of groups within other professional/standards bodies to address DIS++ needs
    3. sponsor conferences on specific subjects to supplement the semi-annual conferences.The vision is not to become the center of the M&S universe but to be a crossroads where all the components of the M&S community can come to share ideas, needs, questions, and answers.

- Question:
  Who is the ultimate end-user community? Is it big government programs or millions of low budget home users using 28.8kbps modems on 486/Windows platforms and wanting new thrills every month (Which market is bigger? and which will ultimately set the standards?).

  - Answer:
    Today the dominant customers of standards for distributed simulation are military organizations. However, many within the DIS/HLA/DIS++ community feel that distributed real-time simulation over the Internet may be the next 'killer application' for computers. Multi-player games (some of which use DIS standards) are already quite popular.

    VRML (Virtual Reality Modeling Language) is a major force in setting standards for distributed simulation via the Internet. Links are already being forged between the DIS++ and VRML communities. We hope to expand these links via the DIS++ outreach program.

- Question:
  My lasting impression from reading the VIP is that the community seems to be addressing in what form the community should continue and the processes and structures by which it can keep itself employed. How will the application of DIS/DIS++ be encouraged, developed and supported in the future?

- Answer:
  1. DIS++ will be expanded to include as much of the M&S community as can possibly be brought into it.
  2. One day of each DIS++ conference will be devoted to user community forums. These forums will be excellent vehicles for the continuing development and support of DIS++ products.

Processes

- Question:
  The processes proposed don't appear to be anything special and don't, on the surface, appear to be that much different from before. Are they?

  - Answer:
    In many ways the proposed processes are a formalization of processes that have in effect for the past few years. In the early days of DIS the conference and work groups were small enough to effectively develop standards. As the size and number of groups increased the task of standards development was assigned to ad hoc teams from within working groups. These teams had little formal guidance.

    The separation of standards development activities from the conference and the establishment of formal processes are efforts to make standards development more efficient and more accountable in the large community that DIS++ has become.

Information Technology

- Question:
  Will the architecture work address the issue of 'plug-ins' for DIS++ compatible software to allow new protocol elements to be incorporated, experimented with and exploited rapidly?

  - Answer:
    There is nothing planned along these lines, but such an approach will not be precluded. Please expand on this issue and state what you would like to see in either the conference or standards development structure that would enable such a capability.

Bijlage D The Way Ahead ... DIS++

The Way Ahead ... DIS++

THE STEP FORWARD

The Steering Committee for the Workshop on Standards for the Interoperability of Distributed Interactive Simulations took a bold step forward during their interim meeting on 12-13 February 1996. After an in-depth assessment of the current workshop direction and the rapidly emerging baseline definition of a High Level Architecture supporting the full spectrum of modeling and simulation applications, the Steering Committee voted unanimously ***to expand the scope of DIS to include all modeling and simulation application domains.*** In so doing all the members of the Steering Committee made the following commitment:

> *"The DIS Steering Committee desires to support the entire DOD modeling and simulation community with a set of standards which include the High Level Architecture and will embark on whatever organizational and management restructuring is required to accomplish this."*

This commitment recognizes the DOD as the principal sponsor for standards development but does not in any way limit the expansion of sponsorship across a wider base.

BENEFIT

In taking this step, the Steering Committee seizes the opportunity for implementing the "The DIS Vision" prepared in 1994. In particular, the incorporation of the High Level Architecture fills the long standing void expressed in the vision document:

> *"Foremost among the technical challenges is the design and promulgation of a comprehensive architecture. A well defined architecture is essential to provide the framework for the application of DIS concepts...and....to insure independent developers apply the standards in a consistent manner."*

Moreover, this action allows expanding the standards development activities to serve the full range of interest of the entire modeling and simulation community.

TRANSITION

A Special Task Group for a Vision Implementation Plan (STGVIP) has been formed to prepare a plan for transitioning the current standards development activities to meet the objective. The outline of the plan will be prepared by the March 1996 workshop followed thereafter by an initial and final draft version at six week intervals. The Coordinating Committee along with others they may select will serve as an advisory group to the STGVIP. Members of the Steering Committee along with others from communities not represented in the current standards development activities will be asked to provide assistance to the STGVIP where needed. Provisions will be made for public review and comment on the transition plan as it develops.

IMPLEMENTATION

Implementation of "The Way Ahead" will begin during the interim meetings held following the 14th Workshop and in the call for position papers. The 15th workshop in September 1996 will introduce the "new look" described by the vision implementation plan with the full implementation being complete by the following workshop.

DIS++

We have chosen "DIS++" as the new name to represent our expanded scope. In selecting the name, consideration was given to DIS 97 to emphasize the urgency for going forward and DIS 2000 to emphasize the breadth of investment base which will rely on the next generation of standards. However, the name "DIS ++" has been selected as the way of communicating the essential objective of expanding the standards development activities to include both the High Level Architecture and other members of the modeling and simulation community

HOW TO STAY INFORMED

Information regarding status and progress on "The Way Ahead" may be obtained from the following web sites:

STGVIP Activities: `http://www.sc.ist.ucf.edu/~STDS/`
HLA Activities: `http://www.dmso.mil/projects/hla/`

EMPLOYMENT OPPORTUNITY

Volunteers will be needed who are willing to take on new challenges.

Salary: Negotiable, as long as it is in multiples of zero.
Job Satisfaction: Immense to those who revel in the advancement of beneficial technology.

We are an equal opportunity organization. Current workshop participants are encouraged to hang in and hang on. Participants of all modeling and simulation persuasions outside the traditional DIS community are encouraged to give employment here a try.

The DIS Steering Committee

REPORT DOCUMENTATION PAGE
(MOD-NL)

1. DEFENCE REPORT NO (MOD-NL)	2. RECIPIENT'S ACCESSION NO	3. PERFORMING ORGANIZATION REPORT NO
TD96-0384		FEL-96-A273
4. PROJECT/TASK/WORK UNIT NO	**5. CONTRACT NO**	**6. REPORT DATE**
6025897	A95KL841	December 1996
7. NUMBER OF PAGES	**8. NUMBER OF REFERENCES**	**9. TYPE OF REPORT AND DATES COVERED**
54 (incl 4 appendices, excl RDP & distribution list)	-	

10. TITLE AND SUBTITLE

DIS, DIS++ en de High Level Architecture
(DIS, DIS++ and the High Level Architecture)

11. AUTHOR(S)

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13. SPONSORING AGENCY NAME(S) AND ADDRESS(ES)

DMKL/B&B/T&WO
Van der Burchlaan 31, 2597 PC The Hague, The Netherlands

14. SUPPLEMENTARY NOTES

The classification designation Ongerubriceerd is equivalent to Unclassified, Stg. Confidentieel is equivalent to Confidential and Stg. Geheim is equivalent to Secret.

15. ABSTRACT (MAXIMUM 200 WORDS (1044 BYTE))

In this report an outline is given about last year's developments of distributed simulation and its standardization for interoperability of simulations. It highlights the functionality of the DIS protocols and Protocol Data Units to be added to the IEEE 1278.1 standard (DIS 2.1: Environmental, Intercom, Mines, Reliable Simulation Management, Entity Management), as well as the evolution of the DIS Workshops and its transition to the High Level Architecture (HLA).
Main subject is the High Level Architecture Initiative of the DoD DMSO. This HLA is introduced and explored as a new standard interface which should permit the interoperability of federations of simulations/simulators across different time domains and levels of scenario.

16. DESCRIPTORS	IDENTIFIERS
Distributed interactive simulations	Distributed simulation
Standards	Simulation interoperability
Interoperability	High level architecture
Security	Run time infrastructure
	Protocol data units

17a. SECURITY CLASSIFICATION (OF REPORT)	17b. SECURITY CLASSIFICATION (OF PAGE)	17c. SECURITY CLASSIFICATION (OF ABSTRACT)
Ongerubriceerd	Ongerubriceerd	Ongerubriceerd

18. DISTRIBUTION AVAILABILITY STATEMENT	17d. SECURITY CLASSIFICATION (OF TITLES)
Unlimited Distribution	Ongerubriceerd

Distributielijst

1.	Bureau TNO Defensieonderzoek
2.	Directeur Wetenschappelijk Onderzoek en Ontwikkeling*)
3.	HWO-KL
4.	HWO-KLu*)
5.	HWO-KM*)
6.	HWO-CO*)
7 t/m 9.	KMA, Bibliotheek
10.	DMKL/B&B/T&WO, Ing. F.P. Remmerswaal
11.	DMKL/INFO/SIM, LKol. Ir. R.A.E. Ficke
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28.	Archief TNO-FEL, in bruikleen aan Drs. R.J.D. Elias
29.	Archief TNO-FEL, in bruikleen aan Ir. W.G. de Jong
30.	Archief TNO-FEL, in bruikleen aan Ir. H.A.M. Luiijf
31.	Documentatie TNO-FEL
32.	Reserve
	TNO-PML, Bibliotheek**)
	TNO-TM, Bibliotheek**)
	TNO-FEL, Bibliotheek**)

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*) Beperkt rapport (titelblad, managementuittreksel, RDP en distributielijst).
**) RDP.